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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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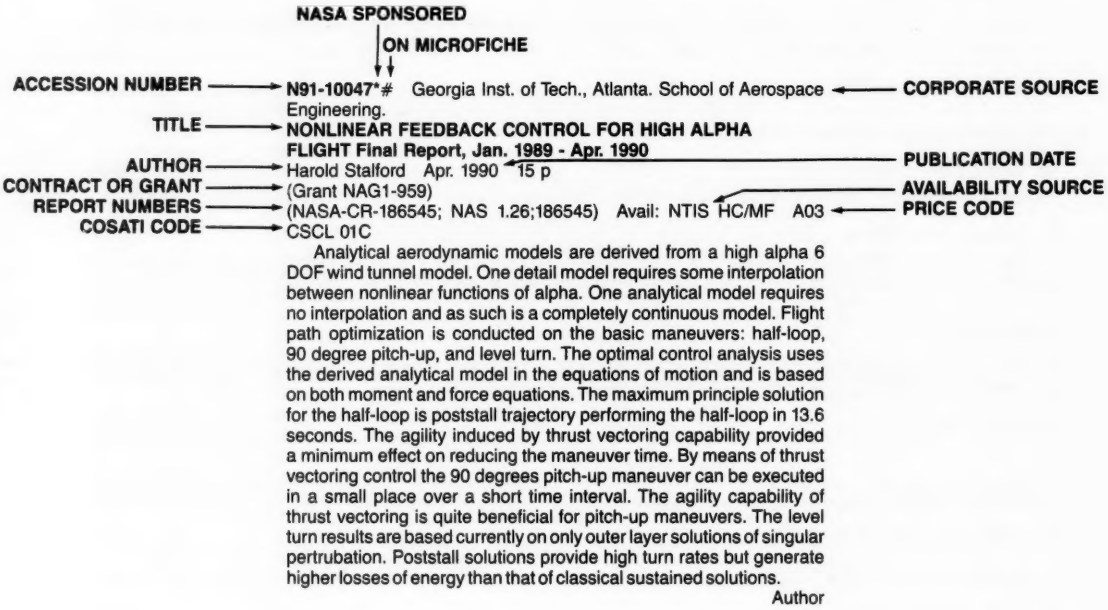
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ACCESSION NUMBER
N91-10047*# Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.
CORPORATE SOURCE
TITLE
NONLINEAR FEEDBACK CONTROL FOR HIGH ALPHA
FLIGHT Final Report, Jan. 1989 - Apr. 1990
PUBLICATION DATE
AUTHOR
Harold Stalford Apr. 1990 15 p
CONTRACT OR GRANT
(Grant NAG1-959)
AVAILABILITY SOURCE
REPORT NUMBERS
(NASA-CR-186545; NAS 1.26;186545) Avail: NTIS HC/MF A03
PRICE CODE
COSATI CODE
CSCL 01C
Analytical aerodynamic models are derived from a high alpha 6 DOF wind tunnel model. One detail model requires some interpolation between nonlinear functions of alpha. One analytical model requires no interpolation and as such is a completely continuous model. Flight path optimization is conducted on the basic maneuvers: half-loop, 90 degree pitch-up, and level turn. The optimal control analysis uses the derived analytical model in the equations of motion and is based on both moment and force equations. The maximum principle solution for the half-loop is poststall trajectory performing the half-loop in 13.6 seconds. The agility induced by thrust vectoring capability provided a minimum effect on reducing the maneuver time. By means of thrust vectoring control the 90 degrees pitch-up maneuver can be executed in a small place over a short time interval. The agility capability of thrust vectoring is quite beneficial for pitch-up maneuvers. The level turn results are based currently on only outer layer solutions of singular pertrubation. Poststall solutions provide high turn rates but generate higher losses of energy than that of classical sustained solutions.
Author

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Scientific and Technical Aerospace Reports

A Semimonthly Publication of the National Aeronautics and Space Administration

01 AERONAUTICS (GENERAL)

N91-25100# Federal Aviation Administration, Atlantic City, NJ.
NAS OPERATIONAL TEST AND EVALUATION/INTEGRATION OF THE MAINTENANCE MANAGEMENT SYSTEM (MMS) TEST PROCEDURES
Frances M. Bayne, Cheryl Krouse, Corey Bolling, Edward Palka, Joseph Pointkowski, and Edward Szydlowski Jun. 1991 426 p (DOT/FAA/CT-TN90/63) Avail: NTIS HC/MF A19

The Maintenance Management System (MMS) is an integral part of the Maintenance Processor Subsystem (MPS) which is a major component of the Remote Maintenance Monitoring System (RMMS). The RMMS provides the means for centralized processing and storage of maintenance-related data. The MMS is the major tool for managing the maintenance and operations functions of National Airspace System (NAS) facilities and equipment. The NAS Operational Test and Evaluation (OT and E)/Integration of the MMS Test Procedures are given. The test location, test schedule, manning and responsibilities, test configurations, test assumptions and interdependencies, and test operational instructions are defined. The NAS OT and E/Integration of the MMS Test Procedures was developed to validate the Phase 1 functions of the MMS. Phase 1 includes Periodic Maintenance/Certification (PM/CERT) Scheduling, Report Generation, Facility/Service/Equipment Profiles (FSEP), Logging, and Administration, together with interfaces to the Interim Monitor and Control Software (IMCS), TRANSFER/MAIL application of Tandem Computers Incorporated, and the National Airspace Performance Reporting System (NAPRS). ACN-230 personnel will conduct the NAS OT and E/Integration of the MMS on the ACN-230 MPS located at the Federal Aviation Administration (FAA) Technical Center, Atlantic City International Airport, New Jersey. The MMS versions to be tested will be A03, A03.01, A03.1, and A03.2. The MMS performance requirements will not be verified during this test effort but will be verified during the MPS Performance Test, as outlined in the MPS Performance Test Plan. Author

N91-25101# Federal Aviation Administration, Atlantic City, NJ.
NAS OPERATIONAL TEST AND EVALUATION/INTEGRATION OF THE MAINTENANCE MANAGEMENT SYSTEM (MMS) TEST REPORT
Frances M. Bayne, Cheryl Krouse, Corey Bolling, Edward Palka, Joseph Pointkowski, and Edward Szydlowski Jun. 1991 156 p (DOT/FAA/CT-TN90/27) Avail: NTIS HC/MF A08

The results of the National Airspace System (NAS) Operational Test and Evaluation (OT and E)/Integration of the Maintenance Management System (MMS) conducted by ACN-230 on the ACN-230 Maintenance Processor Subsystem (MPS) located at the Federal Aviation Administration Technical Center. The MMS versions tested were A03, A03.01, A03.1, and A03.2. ACN-230 identified two major exceptions and a number of minor exceptions during testing of version A03 and A03.01. ACN-230 reported these exceptions to the Maintenance Automation Software Program via a letter of findings. ACN-230 retested these exceptions during testing of version A03.2. The two major exceptions were found to have been corrected. ACN-230 concludes that the MMS satisfies the requirements specified in NAS-SS-1000 and the MMS Software Requirements Specification (SRS) and recommends that the MMS be deployed for field use. Author

N91-25102*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
APPLICATIONS OF HIGHER HARMONIC CONTROL TO HINGELESS ROTOR SYSTEMS
Khanh Nguyen and Inderjit Chopra (Maryland Univ., College Park.) Mar. 1991 15 p Previously announced in IAA as A91-28471 Submitted for publication
(NASA-TM-103846; A-90263; NAS 1.15:103846) Avail: NTIS HC/MF A03 CSCL 01B

A comprehensive analytical formulation was developed to predict the vibratory hub loads of a helicopter rotor system in forward flight. This analysis is used to calculate the optimal higher harmonic control inputs and associated actuator power required to minimize these hub loads. The present formulation is based on a finite element method in space and time. A nonlinear time domain, unsteady aerodynamic model is used to obtain the airloads, and the rotor induced inflow is calculated using a nonuniform inflow model. Predicted vibratory hub loads are correlated with experimental data from a scale model rotor. Results of a parametric study on a hindgeless rotor show that blade flap, lag and torsion vibration characteristics, offset of blade center of mass from elastic axis, offset of elastic axis from quarter-chord axis, and blade thrust greatly affect the higher harmonic control actuator power requirement. Author

02 AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

For related information see also *34 Fluid Mechanics and Heat Transfer.*

N91-25103*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LOW-SPEED, POWERED GROUND EFFECTS OF A GENERIC, HYPERSONIC CONFIGURATION
Gregory M. Gatlin [1990] 62 p
(NASA-TP-3092; L-16861; NAS 1.60:3092) Avail: NTIS HC/MF A04 CSCL 01A

A study was undertaken in the NASA Langley 14- by 22-foot subsonic tunnel to determine the low-speed aerodynamic characteristics of a powered, generic, hypersonic configuration in ground effect. The model was a simplified configuration consisting of a triangular wedge forebody, a rectangular mid-section which housed the flow through, an ejector type propulsion simulation system, and a rectangular wedge afterbody. Additional model components included a delta wing, a rectangular wedge forebody, inlet fences, exhaust flow deflectors, and afterbody fences. Aerodynamic force and moment data were obtaind over an angle of attack range from -4 to 18 degrees while model height above the tunnel floor was varied from 1/4 inch to 6 feet. Variations in freestream dynamic pressure, from 10 psf to 80 psf, and engine ejector pressure yielded a range of thrust coefficients from 0 to 0.8. Author

N91-25104*# High Technology Corp., Hampton, VA.
TESTING OF TRANSITION-REGION MODELS: TEST CASES AND DATA
Bart A. Singer, Surya Dinavahi, and Venkit Iyer (Vigyan Research Associates, Inc., Hampton, VA.) Washington NASA May 1991 84 p Prepared in cooperation with Vigyan Research Associates, Inc., Hampton, VA
(Contracts NAS1-18240; NAS1-18599; NAS1-18585)
(NASA-CR-4371; NAS 1.26:4371) Avail: NTIS HC/MF A05 CSCL 01A

Mean flow quantities in the laminar turbulent transition region and in the fully turbulent region are predicted with different models incorporated into a 3-D boundary layer code. The predicted quantities are compared with experimental data for a large number of different flows and the suitability of the models for each flow is evaluated. Author

N91-25105*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
THREE DIMENSIONAL UNSTRUCTURED MULTIGRID FOR THE EULER EQUATIONS Final Report
D. J. Mavriplis May 1991 30 p Submitted for publication
(Contract NAS1-18605)
(NASA-CR-187565; NAS 1.26:187565; ICASE-91-41) Avail: NTIS HC/MF A03 CSCL 01A

The three dimensional Euler equations are solved on unstructured tetrahedral meshes using a multigrid strategy. The driving algorithm consists of an explicit vertex-based finite element scheme, which employs an edge-based data structure to assemble the residuals. The multigrid approach employs a sequence of independently generated coarse and fine meshes to accelerate the convergence to steady-state of the fine grid solution. Variables, residuals and corrections are passed back and forth between the various grids of the sequence using linear interpolation. The addresses and weights for interpolation are determined in a preprocessing stage using linear interpolation. The addresses and weights for interpolation are determined in a preprocessing stage using an efficient graph traversal algorithm. The preprocessing operation is shown to require a negligible fraction of the CPU time required by the overall solution procedure, while gains in overall solution efficiencies greater than an order of magnitude are demonstrated on meshes containing up to 350,000 vertices. Solutions using globally regenerated fine meshes as well as adaptively refined meshes are given. Author

N91-25106*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
EVALUATION OF PANEL CODE PREDICTIONS WITH EXPERIMENTAL RESULTS OF INLET PERFORMANCE FOR A 17-INCH DUCTED PROP/FAB SIMULATOR OPERATING AT MACH 0.2
D. R. Boldman, C. Iek, D. P. Hwang, R. J. Jeracki, M. Larkin, and G. Sorin (Pratt and Whitney Aircraft, East Hartford, CT.) 1991 18 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; sponsored by AIAA, SAE, ASME, and the American Society for Electrical Engineers
(NASA-TM-104428; E-6261; NAS 1.15:104428; AIAA-91-3354)
Avail: NTIS HC/MF A03 CSCL 01A

An axisymmetric panel code was used to evaluate a series of ducted propeller inlets. The inlets were tested in the Lewis 9 by 15 Foot Low Speed Wind Tunnel. Three basic inlets having ratios of shroud length to propeller diameter of 0.2, 0.4, and 0.5 were tested with the Pratt and Whitney ducted prop/fan simulator. A fourth hybrid inlet consisting of the shroud from the shortest basic inlet coupled with the spinner from the largest basic inlet was also tested. This later configuration represented the shortest overall inlet. The simulator duct diameter at the propeller face was 17.25 inches. The short and long spinners provided hub-to-tip ratios of 0.44 at the propeller face. The four inlets were tested at a nominal free stream Mach number of 0.2 and at angles of attack from 0 degrees to 35 degrees. The panel code method incorporated a simple two-part separation model which yielded conservative estimates of inlet separation. Author

N91-25107*# Purdue Univ., West Lafayette, IN. School of Aeronautics and Astronautics.
A QUIET FLOW LUDWIEG TUBE FOR STUDY OF TRANSITION IN COMPRESSIBLE BOUNDARY LAYERS: DESIGN AND FEASIBILITY Final Report, 1 May 1990 - 1 May 1991
Steven P. Schneider 27 Jun. 1991 34 p
(Grant NAG1-1133)
(NASA-CR-188499; NAS 1.26:188499) Avail: NTIS HC/MF A03 CSCL 01A

Laminar-turbulent transition in high speed boundary layers is a complicated problem which is still poorly understood, partly because of experimental ambiguities caused by operating in noisy wind tunnels. The NASA Langley experience with quiet tunnel design has been used to design a quiet flow tunnel which can be constructed less expensively. Fabrication techniques have been investigated, and inviscid, boundary layer, and stability computer codes have been adapted for use in the nozzle design. Construction of such a facility seems feasible, at a reasonable cost. Two facilities have been proposed: a large one, with a quiet flow region large enough to study the end of transition, and a smaller and less expensive one, capable of studying low Reynolds number issues such as receptivity. Funding for either facility remains to be obtained, although key facility elements have been obtained and are being integrated into the existing Purdue supersonic facilities. Author

N91-25108 Mississippi State Univ., Starkville.
A DRAG ANALYSIS OF THE EARLY STAGES OF LARGE-SCALE HIGH-ALTITUDE FREE BALLOON ASCENTS Ph.D. Thesis
James Raymond Crump 1990 87 p
Avail: Univ. Microfilms Order No. DA9108938

A drag analysis is performed for the early stages of large scale high altitude balloon ascents. The investigation is developed through an energy method based on motion and added mass. Relations are derived for general buoyant objects and then specifically applied to actual balloon ascents. Among the results of these relations are: an added mass coefficient based on motion history; a time constant for general buoyant objects; and the effects of lifting gas uncertainty on the drag coefficient. The analysis reveals that the drag effects due to steady motion are the most significant for a majority of the early portion of ascent. Drag coefficients are obtained and the sensitivity of their value is discussed with respect to buoyancy. Actual experimental data demonstrate the abnormally high drag of these vehicles when compared to objects of similar Reynolds number. Dissert. Abstr.

N91-25109 Maryland Univ., College Park.
CHEMICALLY REACTING EFFECTS ON HYPERSONIC VISCOUS INTERACTION Ph.D. Thesis
Wayne Ford Hallgren 1990 191 p
Avail: Univ. Microfilms Order No. DA9110303

The effects of chemical reactions on the classic hypersonic viscous interaction ar investigated. The case considered is that of a nonequilibrium chemically reacting flow, because the external flow conditions that encourage strong viscous interaction are the same as those promoting nonequilibrium chemistry phenomena. The flow is treated as a chemically reacting mixture of thermally perfect species. Also, the effects of a noncatalytic wall and a fully catalytic wall are considered. The complete Navier-Stokes equations, including multicomponent diffusion, are solved using an explicit-difference time marching scheme. To assess the effects of finite-rate chemistry, the results are compared to a solution assuming the air behaves as a calorically perfect gas. All calculations are for a sharp flat plate at zero incidence. Data are presented to emphasize a physical understanding of hypersonic viscous interaction, and the effects introduced by the addition of chemical reactions. Dissert. Abstr.

N91-25110 Washington Univ., Seattle.
SELF-PROPELLED SLENDER AXISYMMETRIC BODY FLOWS: ERRORS IN THE POISSON EQUATION FIELD CALCULATION Ph.D. Thesis
Peng Yip Ho 1990 173 p
Avail: Univ. Microfilms Order No. DA9109803

The present study was motivated by an interest in the interactive flow of self-propelled low drag bodies. Two approaches for finding flow solutions to the axisymmetric Poisson equation were investigated: first, by superposition of a number of simpler solutions; second, the partial differential equation were approximated by a finite difference equation. In the first approach, point sources located on the body centerline are used to model the body. Numerical experiments using this approach to model a sphere demonstrated the method's susceptibility to round-off errors which prove this technique to be unacceptable for modeling flows about high aspect ratio bodies. The accuracy of the method is sensitive to how floating point numbers and operations are treated by the machine and software. A set of guidelines for using the axial source method is proposed to avoid gross errors in the computations. In the second approach, the governing partial differential equations are expressed in terms of the stream function. The nonlinearity of the flow field is reflected in a highly nonlinear stream function field. This means that the higher order spatial derivatives of the stream function cannot be neglected with respect to the first and second order spatial derivatives in the governing equation. The truncation of these higher order terms in the finite difference approximation results in significant errors. The nonlinearity of the flow is greatest in regions that are dominated by vorticity because of the large velocity gradients. These regions include the propeller slipstream, and the viscous boundary layer. Use of higher order finite difference approximations may not reduce the truncation error because of the difficulty of maintaining consistent higher order approximation of the derivatives adjacent to the body surface. The finite difference approximation to the stream function is, therefore, an inaccurate means of modeling the high Reynolds number propeller-hull interaction phenomenon. The method is accurate for low Reynolds number flows, as the truncation error vanishes for these flows. Dissert. Abstr.

N91-25111 Maryland Univ., College Park.
DYNAMIC ANALYSIS OF ADVANCED TIP ROTORS INCLUDING THREE-DIMENSIONAL AERODYNAMICS Ph.D. Thesis
Ki Chung Kim 1990 277 p
Avail: Univ. Microfilms Order No. DA9110317

A systematic investigation of the effects of tip sweep, anhedral, and planform taper on helicopter rotor blade response and loads is conducted using comprehensive structural and aerodynamic models. A finite element method is used for the structural analysis, and a three-dimensional (3D) finite difference aerodynamic analysis, based on unsteady transonic small disturbance theory (TSD), is used to calculate the aerodynamic loads. The blade and its tip are treated as elastic beams undergoing flap bending, lag bending, elastic twist and axial deflections. Nonlinear transformation relations based on moderate rotations are used to assemble the blade and tip elements. The blade response is calculated from nonlinear periodic normal mode equations using a finite element in time scheme. To represent the inflow distributions through the rotor disk, a free wake model is used. Dynamic stall and reverse flow effects are also included. Vehicle trim and rotor elastic response are calculated as one coupled solution using Newton's method. The blade steady response, rotor controls and blade loads are recalculated using the three dimensional lift and moment obtained from the TSD analysis. An iterative coupling scheme is developed for efficient coupling between the aeroelastic and 3D finite difference codes. Calculated results are correlated satisfactorily with flight test data obtained from the Gazelle helicopter (with a straight-tip blade) for several level flight conditions. Results are then calculated for this rotor with advanced tip shapes and the effects of 3D aerodynamics are assessed. For a high forward speed condition, there is a considerable influence of 3D aerodynamics on blade response and loads and the correlation of aerodynamic loads is improved with the inclusion of 3D aerodynamics, particularly near the outboard section of the blade. Inclusion of 3D effects in pitching moment appears quite large and helps to improve the correlation for torsional moment in the high speed case. Tip sweep introduces a kinematic axial-lag coupling induced by the centrifugal force. Dissert. Abstr.

N91-25112 Cincinnati Univ., OH.
THEORY AND EXPERIMENTS ON SUBCRITICAL COMPRESSIBLE GAS FLOW METERING Ph.D. Thesis
Daniel John Lahti 1990 144 p
Avail: Univ. Microfilms Order No. DA9108748

Historically, when high accuracy compressible gas flow measurements are required, flow meters designed for critical (choked) conditions have been used. Two standard critical flow meter designs whose discharge coefficients have been well established are now widely used throughout the world for such measurements. However, in many situations, either critical flow conditions cannot be achieved or these standard meters cannot be adapted to the physical setup of the installation where flow measurements are to be made. Usually, when subcritical flow conditions exist, measurement errors increase, and when non-standard meter designs must be used, their discharge coefficients must be determined first. When high flow rates exist, the only known way for obtaining the discharge coefficients of non-standard flow meters is to determine them theoretically. The objectives were: (1) to study the factors leading to increase errors in sub-critical flow metering; (2) utilize existing theoretical methods to design a new sub-critical flow meter for very high accuracy; (3) predict its discharge coefficient; and (4) then experimentally verify it by calibration with an industry standard critical flow meter. Detailed comparisons of the theoretical and experimental results are shown, and the effects of uncertainties in the experimental results are assessed for their impact on discharge coefficient. Finally, recommendations are made for a proposed new standard low pressure loss subcritical flow meter. Dissert. Abstr.

N91-25113*# General Motors Corp., Indianapolis, IN. Allison Gas Turbine Div.
INVESTIGATION OF ADVANCED COUNTERROTATION BLADE CONFIGURATION CONCEPTS FOR HIGH SPEED TURBOPROP SYSTEMS. TASK 2: UNSTEADY DUCTED PROPFAN ANALYSIS Final Report
Edward J. Hall, Robert A. Delaney, and James L. Bettner May 1991 132 p Original contains color illustrations
(Contract NAS3-25270)
(NASA-CR-187106; NAS 1.26:187106) Avail: NTIS HC/MF A07; 7 functional color pages CSCL 01A

The primary objective was the development of a time dependent 3-D Euler/Navier-Stokes aerodynamic analysis to predict unsteady compressible transonic flows about ducted and unducted propfan propulsion systems at angle of attack. The resulting computer codes are referred to as Advanced Ducted Propfan Analysis Codes (ADPAC). A computer program user's manual is presented for the ADPAC. Aerodynamic calculations were based on a four stage Runge-Kutta time marching finite volume solution technique with added numerical dissipation. A time accurate implicit residual smoothing operator was used for unsteady flow predictions. For unducted propfans, a single H-type grid was used to discretize each blade passage of the complete propeller. For ducted propfans, a coupled system of five grid blocks utilizing an embedded C grid about the cowl leading edge was used to discretize each blade passage. Grid systems were generated by a combined algebraic/elliptic algorithm developed specifically for ducted propfans. Numerical calculations were compared with experimental data for both ducted and unducted flows. Author

N91-25114# National Aerospace Lab., Tokyo (Japan).
A COMPUTATIONAL AND EXPERIMENTAL ANALYSIS OF JOINED-WING AERODYNAMICS
Naoki Hirose, Takeshi Ohnuki, Masakata Hashimoto, and Masayuki Ishikawa (Mitsui Engineering and Shipbuilding Co. Ltd., Tokyo,

Japan) Nov. 1990 24 p In JAPANESE; ENGLISH summary (NAL-TR-1088T; ISSN-0389-4010) Avail: NTIS HC/MF A03

Aerodynamic characteristics of a joined wing were investigated by computational methods and by a low speed wind tunnel experiment for the purpose of understanding the aerodynamic characteristics and advantages of such a wing over conventional configurations, and to examine the feasibility of using it in a practical application. Extended lifting line theory, the three dimensional potential flow panel method, and the finite difference method were used. Author

N91-25115# National Aerospace Lab., Tokyo (Japan).
VELOCITY MEASUREMENTS INSIDE THE LEADING EDGE VORTEX FORMED ON A DELTA WING
Kenichi Rinoie, Akihito Iwasaki, Toshimi Fujita, and Hirotoshi Fujieda Nov. 1990 22 p In JAPANESE; ENGLISH summary (NAL-TR-1087; ISSN-0389-4010) Avail: NTIS HC/MF A03

Measurements were made to investigate the three dimensional structure of the leading edge vortex formed on a delta wing with a 60 degree sweep. The behavior of the vortex was studied by means of a lift measurement, surface pressure measurements and flow visualization tests. Mean velocities and velocity fluctuations were measured using a laser two focus velocimeter (L2F). The flow pattern inside the secondary separation vortex is shown from the results of the above measurements. The relationship between the mean velocities and the velocity fluctuations are also shown. Since this was the first time the L2F had been used in the NAL gust wind tunnel, the problem of the present experimental method using the L2F is discussed. Author

N91-25116# National Aerospace Lab., Tokyo (Japan).
AN INVESTIGATION OF A TWO-DIMENSIONAL HYBRID LAMINAR FLOW CONTROL AIRFOIL AT HIGH SUBSONIC FLOW. PART 1: AERODYNAMIC CHARACTERISTIC OF A BASIC AIRFOIL NLAM78
Osamu Nonaka, Yoji Ishida, Mamoru Sato, and Hiroshi Kanda Aug. 1990 27 p In JAPANESE; ENGLISH summary (NAL-TR-1076; ISSN-0389-4010) Avail: NTIS HC/MF A03

The experimentally determined aerodynamic characteristics of the NLAM 78 airfoil section, a natural-laminar airfoil, over the Mach number range 0.6 to 0.85 and angles of incidence from -1 to 4 as well as the Reynolds numbers 8, 16, and 32 million, respectively. The airfoil section was selected as the basic airfoil for the hybrid laminar flow control airfoil study, which is described. The test was executed in the NAL two dimensional transonic wind tunnel with a test section of 0.3 x 1.0 m where measurements of the static pressure on the airfoil surfaces and the wake traverse were made. The test has shown that natural laminar airfoil characteristics are maintained for a flow condition of Mach numbers as high as 0.8 and angles of incidence up to 1 degree, and that the lift to drag ratio for the condition takes very high values of 72 to 85 depending on the Reynolds number. Also, it shows that for the flow condition, the drag divergence Mach number is about 0.82 and drag creep phenomena are rarely observed. Comparisons with the flight data shows quite satisfactory agreement. Also, comparison with some supercritical airfoil with almost the same thickness ratio as the present airfoil confirms the superiority of the aerodynamic characteristics of the NLAM 78 airfoil. Author

N91-25117# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.
LOW-DIFFUSION ROTATED UPWIND SCHEMES, MULTIGRID AND DEFECT CORRECTIONS FOR STEADY, MULTI-DIMENSIONAL EULER FLOWS
Barry Koren Nov. 1990 15 p Presented at 3rd European Conference on Multigrid Methods, Bonn, Fed. Republic of Germany, 1-4 Oct. 1990 Sponsored by ESA; Avions Marcel Dassault-Breguet Aviation; and Netherlands Organization for the Advancement of Research
(CWI-NM-R9021; ETN-91-99414) Copyright Avail: NTIS HC/MF A03

Two simple, multidimensional upwind discretizations for the steady Euler equations are derived, with the emphasis on both accuracy and solvability. The multidimensional upwinding consists of applying a one dimensional Riemann solver with a locally rotated left and right state: the rotation angle depending on the local flow solution. First, a scheme is derived for which smoothing analysis of point Gauss-Seidel relaxation shows that despite its rather low numerical diffusion, it still enables a good acceleration by multigrid. Next, a scheme is derived which does not have any numerical diffusion in crosswind direction, and of which convergence analysis shows that its corresponding discretized equations can be solved efficiently by means of defect correction iteration within the inner multigrid iteration the first scheme. For the steady two dimensional Euler equations, numerical experiments are performed for some supersonic test cases with an oblique contact discontinuity. The numerical experiments are performed for some supersonic test cases with an oblique contact discontinuity. The numerical results are in good agreement with the theoretical predictions. Comparisons are made with results obtained by standard, grid aligned upwind schemes. The grid decoupled results obtained are promising. ESA

N91-25118# Sandia National Labs., Albuquerque, NM.
GRID SENSITIVITY IN LOW REYNOLDS NUMBER HYPERSONIC CONTINUUM FLOWS
W. H. Rutledge and K. A. Hoffmann (Wichita State Univ., KS.) 1991 14 p Presented at the 3rd International Conference on Numerical Grid Generation in Computational Fluid Dynamics and Related Fields, Barcelona, Spain, 3 Jun. 1991
(Contract DE-AC04-76DP-00789)
(DE91-010875; SAND-91-0885C; CONF-9106175-1) Avail: NTIS HC/MF A03

A computational scheme is presented to solve the unsteady Navier-Stokes equations over a blunt body at high altitude, high Mach number atmospheric reentry flow conditions. This continuum approach is directed to low Reynolds/low density hypersonic flows by accounting for non-zero bulk viscosity effects in near frozen flow conditions. A significant difference from previous studies is the inclusion of the capability to model non-zero bulk viscosity effects. The grid definition for these low Reynolds number, viscous dominated flow fields is especially important in terms of numerical stability and accurate heat transfer solutions. DOE

N91-25343*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A NUMERICAL STUDY OF HYPERSONIC FOREBODY/INLET INTEGRATION PROBLEM
Ajay Kumar *In* JHU, Computational Fluid Dynamics Code Validation/Calibration. JANNAF Airbreathing Propulsion Subcommittee Workshop: High-Speed Inlet Forebody Interactions Jan. 1991 p 131-154 (For primary document see N91-25336 17-34)
Avail: NTIS HC/MF A06 CSCL 01A

03 AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

For related information see also *16 Space Transportation* and *85 Urban Technology and Transportation.*

N91-25119# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Flight Mechanics Panel.
TECHNICAL EVALUATION REPORT ON THE FLIGHT MECHANICS PANEL SYMPOSIUM ON PROGRESS IN MILITARY AIRLIFT
F. Mary May 1991 26 p Symposium held in Lisbon, Portugal, 28-31 May 1990
(AGARD-AR-300; ISBN-92-835-0619-7) Copyright Avail: NTIS HC/MF A03; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Although military transport aircraft and helicopters continue to

be of increasing importance in future military operations, military transport aircraft technology has not received the same level of attention that has been directed, for example, to combat aircraft. In-service fleets of transport aircraft are also becoming physically old and technically outdated, and are less and less capable of fulfilling the more demanding mission requirements. It was therefore important and timely to review the area of military airlift and assess: the present and perceived future military roles and requirements; the required developments in technology; the extent to which civil technology applications can enhance capability; technologies for real cost reduction; and to what extent the current and future development programs in this field embody the new technologies. To accomplish this review and assessment, a Symposium was held that included sessions on operational experience and requirements; cockpit design and aircrew performance; specific technologies such as fuel, powerplant and aerodynamic design; and a review of current and new programs. Author

N91-25120# Department of the Navy, Washington, DC.
PIVOTING SEAT FOR FIGHTER AIRCRAFT Patent Application
Chi Tung, inventor (to Navy) 26 Sep. 1990 14 p
(AD-D014822; US-Patent-Appl-SN-589703) Avail: NTIS HC/MF A03 CSCL 01/3

A high-performance aircraft seat is disclosed that automatically reacts to recline the pilot as the aircraft experience higher G's in the vertical direction, or along the pilot's Z-axis. The seat, consisting of a seat pan joined to a seat back, is hingedly fixed, at a point forward of the pilot/seat combination center of gravity, to the surface. An hydraulic cylinder is fixed between the surface, aft of the hinge point, and the seat back and will react to return the seat to its initial position, from a G-force induced reclining position, whenever the G forces subside. GRA

04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

For related information see also *17 Space Communications, Spacecraft Communications, Command and Tracking* and *Communications and Radar.*

N91-25121# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Guidance and Control Panel.
KNOWLEDGE BASED SYSTEM APPLICATIONS FOR GUIDANCE AND CONTROL
Apr. 1991 259 p In ENGLISH and FRENCH The 51st symposium was held in Madrid, Spain, 18-21 Sep. 1990
(AGARD-CP-474; ISBN-92-835-0610-3) Copyright Avail: NTIS HC/MF A12; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The overall state-of-the-art of AI applications in the guidance and control area were assessed. The papers were presented covering the following headings: representative applications; design concepts and synthesis techniques; related methods and techniques; information processing and system architecture; and mechanization and integration issues. For individual titles, see N91-25122 through N91-25140.

N91-25122# Lockheed Aeronautical Systems Co., Thousand Oaks, CA.
THE PILOT'S ASSOCIATE: EXPLOITING THE INTELLIGENT ADVANTAGE **c63**
Douglas I. Holmes and John P. Retelle, Jr. (Lockheed Missiles and Space Co., Calabasas, CA.) *In* AGARD, Knowledge Based System Applications for Guidance and Control Apr. 1991 8 p (For primary document see N91-25121 17-04)
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The Pilot's Associate program has provided a series of technology demonstrations of the potential of integrating intelligent systems and artificial intelligence technology into modern avionics systems. The Defense Advanced Research Projects Agency and the United State Air Force have provided funding and program management to determine the potential increases in mission effectiveness from such a system. The Pilot's Associate effort pursued by Lockheed and its partners has produced not only prototypes for advanced systems, but also new insights into the nature of the systems themselves as well as new approaches for quickly producing software for these systems. The rapid prototyping methods that have been utilized have also provided the ultimate consumers (the pilots) with significant awareness of the operation of the Pilot's Associate, and with many opportunities to improve the requirements for such a system. The evolution of Lockheed's Pilot's Associate System approach leading to the current system configuration is described. Also described are some lessons learned from managing a large software development team assembled to produce an unprecedented system. Author

N91-25123# Societe d'Applications Generales d'Electricite et de Mecanique, Cergy-Pontoise (France). Div. Recherche en Automatique.
SCI3: A KNOWLEDGE BASED SYSTEM FOR ON-BOARD ASSISTANCE WITH THE INTERPRETATION OF INFRA-RED IMAGES
D. Morillon, T. Conter, M. DeCremiers, L. Lefort, and F. Germain (ITMI, Meylan, France) *In* AGARD, Knowledge Based System Applications for Guidance and Control Apr. 1991 17 p (For primary document see N91-25121 17-04)
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Infrared sensors are becoming more and more essential on all military vehicles: aircraft, RPVs, boats, tanks, and land robots, because of the extra information they provide, day and night, in all weather conditions and with absolute discretion. A system designed to help in the interpretation of infrared images is presented. Navigation, infrared sensing, and image processing knowledge are used to make interpretation easier, allowing optimal use of onboard data: digital maps, inertial navigation systems, and weather information. This work was validated on a lab prototype. Author

N91-25124# Aeritalia S.p.A., Turin (Italy). Artificial Intelligence Lab.
PATH GENERATION AND EVALUATION FOR A MISSION PLANNING EXPERT SYSTEM
Federica Luise and Danilo Dabbene *In* AGARD, Knowledge Based System Applications for Guidance and Control Apr. 1991 14 p (For primary document see N91-25121 17-04)
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Aeritalia's (Defense Aircraft Group) experience with the problem of path generation and evaluation for a multitarget air to ground planning system working in a limited geographic scenario are described. Since in the same planning operation many goals (each goal is a mission target) must be satisfied, techniques of splitting problems into simpler ones were used as it is not possible to use satisfactory heuristic guided search (like A*). Although these algorithms give an optimal solution for each goal, this doesn't ensure that the union of the solutions that are optimal will be the best for the whole set of goals. The mission is decomposed into submissions, and each one of them is solved finding all the solutions satisfying the forced constraints (e.g., maximum leg length, maximum turn number). All the solutions so generated become a new search space to be used to find out the final best solution. Every submission is represented by a task (a process) that generates all the partial solutions (partial paths) that will be combined in an upper stage by a higher level task (mission task) in order to generate the whole set of global solutions. Currently all the tasks are independent and are managed by a task-scheduler which simulates the behavior of a multiprocessor architecture carrying out the task synchronization by an event generation and waiting mechanism. A few simple primitives allow tasks to generate

events and wait for them. Every submission task built each path as a collection of atomic paths (point-to-point) which may be shared by different solutions of the task. The mission tasks will combine the subtask results, generating a graph whose roots are all possible paths and whose leaves are the atomic paths. The evaluator is a graph which has path feature evaluation nodes and Bayesian combination nodes whose function is to combine evaluations in one single value. The developed prototype was tested by the pilots and the results are described. The system was developed on a Lisp machine Explorer 2 using Lisp and Flavors and later ported on a Symbolics 3630. Author

N91-25125# Universitaet der Bundeswehr Muenchen, Neubiberg (Germany, F.R.). Inst. fuer Systemdynamik und Flugmechanik.
KNOWLEDGE-BASED COCKPIT ASSISTANT FOR IFR OPERATIONS
R. Onken *In* AGARD, Knowledge Based System Applications for Guidance and Control Apr. 1991 9 p (For primary document see N91-25121 17-04)
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A knowledge-based cockpit assistant for IFR (Instrument Flight Rules) operation is presented, aimed at improvement of situation assessment and performance increase by computer aids for flight planning and plan execution. Here, situation assessment also includes monitoring of the pilot's own activities. The modular system structure is described as well as the individual system modules. The cockpit assistant was tested in a flight simulator by professional pilots under realistic IFR-scenarios. The concept of the test design as well as test results are presented. The system design goals are mainly confirmed by these results. Author

N91-25126# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.). Inst. fuer Flugfuhrung.
CONSTRAINT MANAGEMENT REQUIREMENTS FOR ON-LINE AIRCRAFT ROUTE PLANNING
Uwe Teegen *In* AGARD, Knowledge Based System Applications for Guidance and Control Apr. 1991 9 p (For primary document see N91-25121 17-04)
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In the future, the cooperation of pilot and controller will change. Technical advances contributing to this change are a more intelligent airborne Flight Management System (FMS) and a datalink connecting the FMS and Air Traffic Control (ATC). Against this background, concepts for an Experimental Flight Management System and its human-centered system design approach are described. Combined with a basic scenario of future Air Traffic Management (ATM) the requirements for an airborne constraint management subsystem are developed. The fundamentals of aircraft route planning and system operation including considerations on the interaction between constraint management and man-machine interface are discussed and an on-line algorithm for aircraft route planning is presented. The present state of a software prototype and the software and hardware employed are also described. Author

N91-25127# Draper (Charles Stark) Lab., Inc., Cambridge, MA.
PLANNING AND PLANNING MANAGEMENT FOR AUTONOMOUS AND SEMI-AUTONOMOUS VEHICLES
Milton B. Adams and Robert M. Beaton *In* AGARD, Knowledge Based System Applications for Guidance and Control Apr. 1991 13 p (For primary document see N91-25121 17-04)
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Planning systems for autonomous and semi-autonomous vehicles can be reviewed as performing very high level guidance and control functions. The structure of hierarchical planning systems parallels that of the management and decision-making structure of many organizations where long-term, less detailed skeletal plans are developed at the highest levels of the hierarchy, and near-term, fully detailed plans are developed and then implemented by the lower levels. Mission planning systems can be decomposed into planning algorithms and planning management functions. Together, they provide the onboard, intelligent decision-making required to plan and execute the nominal mission and modify mission activities in response to unforeseen events, with little or no reliance on human intervention. Planning Algorithms produce plans of actions that best achieve stated mission objectives within specified mission constraints for a given mission environment. Planning Management Functions control the execution of plans, monitor the progress of the plans currently being executed, decide if replanning is necessary and, if so, define the revised planning problem to be solved by the planning algorithms. An architecture for a mission planning system is presented with descriptions of the associated planning algorithms and planning management functions. Implementation considerations for architectures in that class are discussed, and an approach to stochastic modeling of the planning process implied by such architectures is proposed. Author

N91-25128# Boeing Military Airplane Development, Seattle, WA.
INTELLIGENT REAL-TIME KNOWLEDGE BASED INFLIGHT MISSION MANAGEMENT
George F. Wilber *In* AGARD, Knowledge Based System Applications for Guidance and Control Apr. 1991 9 p (For primary document see N91-25121 17-04)
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The problems and issues of developing a tactical mission manager are described. Development aspects of intelligent real-time avionics are discussed and an efficient real-time AI methodology and implementation for the development of the intelligent systems are outlined. Advanced software development techniques are also outlined and an overview of related Boeing research efforts provided. Author

N91-25129*# Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.
KNOWLEDGE ACQUISITION FOR EXPERT SYSTEMS USING STATISTICAL METHODS **c65**
Brenda L. Belkin and Robert F. Stengel *In* AGARD, Knowledge Based System Applications for Guidance and Control Apr. 1991 17 p (For primary document see N91-25121 17-04)
(Contract NGL-31-001-252; DAAG29-84-K-0048)
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A common problem in the design of expert systems is the definition of rules from data obtained in system operation or simulation. A statistical method for generating rule bases from numerical data, motivated by an example based on aircraft navigation with multiple sensors is presented. The specific objective is to design an expert system that selects a satisfactory suite of measurements from a dissimilar, redundant set, given an arbitrary navigation geometry and possible sensor failures. The systematic development of a Navigation Sensor Management (NSM) Expert System from Kalman Filter covariance data is described. The development method invokes two statistical techniques: Analysis-of-Variance (ANOVA) and the ID3 algorithm. The ANOVA technique indicates whether variations of problem parameters give statistically different covariance results, and the ID3 algorithm identifies the relationships between the problem parameters using probabilistic knowledge extracted from a simulation example set. Author

N91-25130# Air Force Systems Command, Kirtland AFB, NM. Directorate of Aerospace Studies.
KNOWLEDGE EXTRACTION METHODS FOR THE DEVELOPMENT OF EXPERT SYSTEMS **c53**
Manuel Perez, Leopoldo Gemoets, and Robert G. McIntyre (Texas Univ., El Paso.) *In* AGARD, Knowledge Based System Applications for Guidance and Control Apr. 1991 10 p (For primary document see N91-25121 17-04)

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The development of expert systems require the use of engineering techniques which can be used to efficiently and correctly extract the domain knowledge resident within the human expert. To apply these techniques, certain conditions must be met. These conditions are that the candidate expert system domain must be suitable for implementation, that there be a knowledge engineer with a certain level of domain knowledge, and that the right human domain experts be selected in the expert system development effort. A semi-sequential approach to development of techniques is presented which can be used to extract the knowledge from the human expert. Presented are both direct and indirect methods which a knowledge engineer can use to extract this knowledge. Author

N91-25131# Royal Aircraft Establishment, Farnborough (England).

A METHODOLOGY FOR PRODUCING VALIDATED REAL-TIME EXPERT SYSTEMS **c61**

S. A. Cross and M. Grisoni (Logica Ltd., Cambridge, England) *In* AGARD, Knowledge Based System Applications for Guidance and Control Apr. 1991 11 p (For primary document see N91-25121 17-04)

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VORTEX (Validation Of Real Time EXpert systems) is an experimental methodology for building validated expert systems. It considers validation to be an exercise in building confidence in a system in the users, procurers, experts, and developers. It identifies the components of validation concerning each participant and techniques for achieving validation and embeds them in a life cycle suitable for a new technology. The essential points are presented of the methodology along with some experiences from the airborne Antisubmarine (ASW) application developed in parallel with it. Author

N91-25132# Instituto Nacional de Tecnica Aeroespacial, Madrid (Spain).

A REVIEW OF SOME ASPECTS ON DESIGNING FUZZY CONTROLLERS **c63**

E. Trillas, M. Delgado, J. L. Verdegay, and M. A. Vila (Granada Univ., Spain) *In* AGARD, Knowledge Based System Applications for Guidance and Control Apr. 1991 12 p (For primary document see N91-25121 17-04)

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Theoretical and practical aspects are examined of the fuzzy control systems according to the following scope. First, foundations of the fuzzy controllers, and the different ways for implementing them, are described. Second, the management of the information is studied, i.e., the way in which the inferences are made from the expert's knowledge. Usually this is carried out by means of the Generalized Modus Ponens for which, the so-called implication function, is the main tool used to handle it. Hence, depending on the selected type of implication, one has a different version of inference. Finally, the possible implications functions and the consequences of its use are analyzed and discussed. Author

N91-25133# Vanderbilt Univ., Nashville, TN.

A NEURAL NETWORK FOR THE ANALYSIS OF AIRCRAFT TEST DATA **c63**

J. B. Golden and B. A. Whitehead (Tennessee Univ. Space Inst., Tullahoma.) *In* AGARD, Knowledge Based System Applications for Guidance and Control Apr. 1991 13 p (For primary document see N91-25121 17-04)

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With the advent of the USAF's Advanced Tactical Fighter and NASA's National Aerospace Plane, demands for concise test data reduction and interpretation will increase beyond the capabilities of current methodologies. As mission complexity increases it becomes apparent that real time data analysis for flight safety, mission control and test conduct becomes a necessary tool. A neural network is a biologically inspired mathematical model, which can be represented by a directed graph, that has the ability to learn through training. They are excellent for parameter estimation and pattern recognition in signal data. A prototype system is discussed which was designed and implemented to discover patterns in test data from an engine test cell in order to determine if any part of the system is in failure. The results show that a neural net can be used for fault diagnosis in an engine test cell when the problem of fault monitoring and diagnosis is seen as one of pattern recognition. A two layer semilinear feedforward neural net is able to separate simulated sensor data into normal and abnormal classes and the addition of a hidden layer makes the network more resistant to noise and improves its network classifying ability. Author

N91-25134# Royal Aircraft Establishment, Farnborough (England).

AN Ada FRAMEWORK FOR THE INTEGRATION OF KBS AND CONTROL SYSTEM SIMULATIONS **c61**

M. J. Corbin and G. F. Butler *In* AGARD, Knowledge Based System Applications for Guidance and Control Apr. 1991 6 p (For primary document see N91-25121 17-04)

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The application of Ada and an object oriented approach to the design and construction of advanced defence systems are both attracting increasing attention. The Ada language contains some support for object oriented programming but has some notable deficiencies. How to overcome these deficiencies is shown by providing a library for object oriented development in Ada (OODA) which contain facilities to create and manipulate objects and provides support for more general relationships between objects. One of the initial applications of this library was to design a framework for integrating Knowledge Base System (KBS) with control system simulations comprising mixed continuous and discrete time elements. Using this framework it is possible to study the interactions between a Knowledge Based controller and the other more conventional elements of the closed loop to any level of detail required. Author

N91-25135# Fabrica Italiana Apparecchiature Radioelettriche S.p.A., Milan.

EVALUATION OF THE OPTIMAL HOMING POINT FOR MISSILE GUIDANCE

B. Midollini, P. L. Torelli, and G. Balzarotti *In* AGARD, Knowledge Based System Applications for Guidance and Control Apr. 1991 11 p (For primary document see N91-25121 17-04)

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One of the main problems arising in the field of missile guidance is the automatic search and detection of targets, in order to gather the necessary information for the correct homing of the missile. This problem is commonly approached by mounting a seeker (infrared) with an image and data processor on board the missile. The ground scene will present isolated targets and target formations, together with a high level of clutter which produces a number of false alarms. Thus, it is necessary to provide the image and data processor of the missile with algorithms which can automatically eliminate the clutter and the false alarms and detect the true targets. In order for accuracy, only one formation among the various ones in the scene must be cued to the navigation and the weapons systems of the missile; the choice depending on the shape, the disposition, and the distance between targets of the formation. An algorithm developed to evaluate the optimal point for releasing the ammunition is presented. The algorithm is further illustrated by applying it to a practical case and showing the results of this simulation. Author

N91-25136# Grumman Aerospace Corp., Bethpage, NY. Technology Development Section.

DESIGN AND SIMULATION OF AN ADVANCED AIRBORNE EARLY WARNING SYSTEM **c66**

Chien Y. Huang and Manikant D. Lodaya *In* AGARD, Knowledge Based System Applications for Guidance and Control Apr. 1991 10 p (For primary document see N91-25121 17-04)
Copyright Avail: NTIS HC/MF A12; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The results of the design and simulation of an advanced airborne early warning (AEW) system are presented. The approach is based on modeling operator's reasoning and decision processes as well as battlefield strategies. The tasks are divided into threat assessment and tactical planning. The implementation of these subsystems is carried out in a generic expert system shell developed specifically for this purpose. The AEW crew is provided with an advanced display that monitors all transactions. The functionalities of this prototype AEW system are demonstrated using an advanced simulation facility. Simulation results show that decision automation can be accomplished in real time and can prove to be a valuable tool in an AEW environment. Author

N91-25137# Societe d'Applications Generales d'Electricite et de Mecanique, Cergy-Pontoise (France).
SEAN: A NAVIGATION AID EXPERT SYSTEM FOR COMBAT AIRCRAFT
D. Florillon, T. Conter, and M. deCremiers *In* AGARD, Knowledge Based System Applications for Guidance and Control Apr. 1991 13 p In FRENCH; ENGLISH summary (For primary document see N91-25121 17-04)
Copyright Avail: NTIS HC/MF A12; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Technology of fighter aircraft equipment is in constant evolution. Increases in precision of navigation equipment, in number of available means of navigation updating and in onboard computer performance, has increased aircraft capabilities to satisfy modern mission requirements but also has complicated the copilot's tasks. SEAN (Expert System for Navigation Aiding) aboard fighters was designed to assist copilots in their choices and supervise the inertial hybrid navigation system. Use of KOD (Knowledge Oriented Design), a powerful cognitive methodology, associated with robust knowledge validation principles, has allowed development of a prototype of the expert system working with a realistic complete simulation of its onboard environment. Author

N91-25138# McDonnell Aircraft Co., Saint Louis, MO.
INTEGRATED CONTROL AND AVIONICS FOR AIR SUPERIORITY: A KNOWLEDGE-BASED DECISION AIDING SYSTEM **c06**
Donald J. Halski, Robert J. Landy, and James A. Kocher (Wright Research Development Center, Wright-Patterson AFB, OH.) *In* AGARD, Knowledge Based System Applications for Guidance and Control Apr. 1991 9 p (For primary document see N91-25121 17-04)
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An ongoing program is described in which is developed an effective, real time, knowledge based, decision aiding system for air combat. The Integrated Control and Avionics for Air Superiority (ICAAS) program is used to develop, integrate, and demonstrate critical technologies which will enable USAF tactical fighter aircraft to kill and survive when outnumbered as much as four to one by enemy aircraft during air combat. Primary emphasis is placed upon beyond visual range (BVR) multiple target attack capability with provisions for effective transition to close-in combat. Knowledge based pilot decision aiding techniques and expert system methods are used to achieve substantially enhanced offensive and defensive capabilities compared to current operational systems. Situation awareness information and recommended actions are computed to aid the pilot in selecting the most effective attack and defend engagement options. The system maximizes opportunities for missile launch against multiple enemy aircraft while maintaining options to defend when necessary. Sufficient integration and automation are provided for application to a single seat fighter. Author

N91-25139# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
A KNOWLEDGE-BASED SYSTEM DESIGN/INFORMATION TOOL FOR AIRCRAFT FLIGHT CONTROL SYSTEMS **c08**
Dale A. Mackall and James G. Allen (Draper, Charles Stark Lab., Inc., Cambridge, MA) *In* AGARD, Knowledge Based System Applications for Guidance and Control Apr. 1991 14 p (For primary document see N91-25121 17-04)
Copyright Avail: NTIS HC/MF A12; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive CSCL 01C

Research aircraft have become increasingly dependent on advanced electronic control systems to accomplish program goals. These aircraft are integrating multiple disciplines to improve performance and satisfy research objective. This integration is being accomplished through electronic control systems. Systems design methods and information management have become essential to program success. The primary objective of the system design/information tool for aircraft flight control is to help transfer flight control system design knowledge to the flight test community. By providing all of the design information and covering multiple disciplines in a structured, graphical manner, flight control systems can more easily be understood by the test engineers. This will provide the engineers with the information needed to thoroughly ground test the system and thereby reduce the likelihood of serious design errors surfacing in flight. The secondary object is to apply structured design techniques to all of the design domains. By using the techniques in the top level system design down through the detailed hardware and software designs, it is hoped that fewer design anomalies will result. The flight test experiences are reviewed of three highly complex, integrated aircraft programs: the X-29 forward swept wing; the advanced fighter technology integration (AFTI) F-16; and the highly maneuverable aircraft technology (HiMAT) program. Significant operating technologies, and the design errors which cause them, is examined to help identify what functions a system design/informatin tool should provide to assist designers in avoiding errors. Author

N91-25140# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
A STUDY OF AN INTEGRATED IMAGE AND INERTIAL SENSOR SYSTEM
R. Koch, R. Bader, and W. Hinding *In its* Knowledge Based System Applications for Guidance and Control Apr. 1991 6 p (For primary document see N91-25121 17-04)
Copyright Avail: NTIS HC/MF A12; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The target approach over large distances of a cruise missile type vehicle, which is equipped with an imaging infrared sensor aided inertial navigation system, is examined in simulation. The study is based on the idea of using the same image sensor for navigation update and target recognition with subsequent tracking. Knowledge based methods are found to play a key role in solving the difficult image interpretation task for real world scenery. The final extraction of navigation data from the processed and interpreted IR image information, and their combination with the inertial sensor data is based on conventional optimization and filtering techniques. The study shows that the combined information leads to an improvement of navigation data. Filtering techniques are found to be capable of quantitatively estimating major error sources inherent to the gyros and accelerometers. Author

N91-25141# Synetics Corp., Wakefield, MA.
COORDINATION AND SYNCHRONIZATION OF LORAN-C AND GPS TO UNIVERSAL COORDINATED TIME Final Report, Jan. - Aug. 1989
D. H. Amos, J. D. Catlin, W. B. Mohin, R. W. Heldt, and R. B. Goddard Oct. 1989 501 p
(Contract DTCG23-86-A-20022)
(AD-A233221; R/DC-10/89; USCG-D-13-90) Avail: NTIS HC/MF A22 CSCL 17/7

Public Law 100-223, the Airport and Airway Safety and capacity Act of 1987, requires an analysis and report to Congress on the

impact to current users of synchronizing loran-C secondary stations to within 100 Nanoseconds (ns) of Universal Coordinated Time (UTC), and the methods and impact of coordinating the time references of the loran-C and the Global Positioning System (GPS) systems to within 30 ns of each other. The analysis required by law is provided here. The impact on repeatable accuracy of the five loran-C chains covering the United States (excluding Alaska and Hawaii) is analyzed using the Double Range Difference (DRD) model. The model is modified to predict system repeatability in the UTC synchronized environment, when the control regimes synchronizing master and secondary stations to within 0 ns (perfect time-of-emission control), 30 ns (1o), and 100 ns (1o) of UTC are shown. GRA

N91-25142*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
COMPUTER AIDING FOR LOW-ALTITUDE HELICOPTER FLIGHT
Harry N. Swenson May 1991 24 p Presented at the 47th Annual Forum of the American Helicopter Society, Phoenix, AZ, 6-8 May 1991
(NASA-TM-103861; A-91140; NAS 1.15:103861) Avail: NTIS HC/MF A03 CSCL 17G

A computer-aiding concept for low-altitude helicopter flight was developed and evaluated in a real-time piloted simulation. The concept included an optimal control trajectory-generated algorithm based on dynamic programming, and a head-up display (HUD) presentation of a pathway-in-the-sky, a phantom aircraft, and flight-path vector/predictor symbol. The trajectory-generation algorithm uses knowledge of the global mission requirements, a digital terrain map, aircraft performance capabilities, and advanced navigation information to determine a trajectory between mission waypoints that minimizes threat exposure by seeking valleys. The pilot evaluation was conducted at NASA Ames Research Center's Sim Lab facility in both the fixed-base Interchangeable Cab (ICAB) simulator and the moving-base Vertical Motion Simulator (VMS) by pilots representing NASA, the U.S. Army, and the U.S. Air Force. The pilots manually tracked the trajectory generated by the algorithm utilizing the HUD symbology. They were able to satisfactorily perform the tracking tasks while maintaining a high degree of awareness of the outside world. Author

N91-25143# Technische Univ., Delft (Netherlands). Faculty of Geodesy.
RANK DEFECTS OF GPS ORBITAL IMPROVEMENT MODELS Thesis
M. Hamed Nov. 1990 137 p
(ETN-91-99420) Avail: NTIS HC/MF A07

The satellite geodetic models concerning the Global Positioning System (GPS) are investigated. An effort is made to show the influence of errors in the approximate station coordinates on the determination of a baseline (or a network) in the case of static satellite geodesy (for both cases, geometric and dynamic). The influence of satellite orbit errors is shown. The GPS orbit improvement model is investigated for possible rank deficiencies. Principles of GPS phase observations, which lead to the satellite geodetic model are described. The modeling of the parameters and the translocation method is outlined. The design matrix according to least squares adjustment is derived for two cases, namely orbit not solved for and orbit solved for. ESA

N91-25762*# Leeds Univ. (England). Dept. of Electronic and Electrical Engineering.
CURRENT GPS/GLONASS TIME REFERENCE AND UTC
Peter Daly *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 87-95 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 17G

N91-25803*# AUSTRON, Inc., Austin, TX.
GPS/LORAN-C INTEROPERABILITY FOR TIME AND FREQUENCY APPLICATIONS: A SURVEY OF THE TIMES OF ARRIVAL OF LORAN-C TRANSMISSIONS VIA GPS COMMON MODE/COMMON VIEW SATELLITE OBSERVATIONS
Bruce Penrod, Richard Funderburk, and Peter Dana *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 559-574 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 17G

N91-25805*# Politecnico di Torino (Italy).
RECENT DEVELOPMENTS OF LORAN-C IN EUROPE
Sigfrido Leschiutta and Enrico Rubiola *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 583-597 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 17G

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

For related information see also *18 Spacecraft Design, Testing and Performance* and *39 Structural Mechanics*. For land transportation vehicles see *85 Urban Technology and Transportation*.

N91-25144 Kansas Univ., Lawrence.
DEVELOPMENT OF A SYSTEM OF INTERACTIVE COMPUTER PROGRAMS FOR AIRPLANE CONCEPTUAL DESIGN AND ADVANCED AIRPLANE ANALYSIS Ph.D. Thesis
Seyyed Mohammad B. Malaek 1990 302 p
Avail: Univ. Microfilms Order No. DA9110890

Advanced Aircraft Analysis (AAA) is a design environment for the purpose of airplane preliminary design. The characteristics of airplane preliminary design methodologies were the focal point in the development of AAA architecture. The AAA provides a vast variety of help for the designer in the form of descriptions, tables, and graphs to make the decision making process as fast and easy as possible. The most up to date features in computer technology were used to create a user friendly environment which is quite appropriate for the purpose of teaching airplane design. All level-1 preliminary design processes and some level-2 processes were implemented and tested to show the effectiveness of the new design environment. Both analysis of a given airplane and design of a new airplane to meet specified criteria can be performed in the AAA design environment. Dissert. Abstr.

N91-25145# National Aerospace Lab., Tokyo (Japan).
ESTIMATION OF THE AEROELASTIC CHARACTERISTICS FROM FLIGHT TEST DATA OF THE STOL RESEARCH AIRCRAFT ASKA
Oct. 1990 44 p In JAPANESE; ENGLISH summary
(NAL-TR-1083; ISSN-0389-4010) Avail: NTIS HC/MF A03

Flight tests of the short takeoff and landing (STOL) research aircraft ASKA, developed by the National Aerospace Laboratory, were conducted in 1986. Acceleration responses due to turbulence at subcritical speeds were obtained. To estimate the aeroelastic characteristics, the acceleration responses were applied to the method for estimating flutter or divergence boundary from random responses with the aid of the autoregressive process and the mixed autoregressive moving average process. The procedures and results of the estimations are given. Author

N91-25146# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Flight Mechanics Panel.
HANDLING QUALITIES OF UNSTABLE HIGHLY AUGMENTED AIRCRAFT
May 1991 120 p

(AGARD-AR-279; ISBN-92-835-0609-X) Copyright Avail: NTIS HC/MF A06; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Reviewed here are handling quality issues of highly augmented unstable aircraft. Handling qualities criteria for both large and small amplitude longitudinal maneuvers are presented. Basic aerodynamic design, specific issues relating to the feel system and control sensitivity, evaluation techniques, and the handling qualities design process are discussed. The subjects of careful handling, lateral-directional criteria and agility are presented in separate appendices. Author

N91-25481*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SCIENCE REQUIREMENTS AND FEASIBILITY/DESIGN STUDIES OF A VERY-HIGH-ALTITUDE AIRCRAFT FOR ATMOSPHERIC RESEARCH
Philip B. Russell, David P. Lux, R. Dale Reed (PRC Systems Services Co., Hampton, VA.), Max Loewenstein, and Steven Wegener *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 241-242 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 01C

06 AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

For related information see also *19 Spacecraft Instrumentation* and *35 Instrumentation and Photography.*

N91-25138# McDonnell Aircraft Co., Saint Louis, MO.
INTEGRATED CONTROL AND AVIONICS FOR AIR SUPERIORITY: A KNOWLEDGE-BASED DECISION AIDING SYSTEM
Donald J. Halski, Robert J. Landy, and James A. Kocher (Wright Research Development Center, Wright-Patterson AFB, OH.) *In* AGARD, Knowledge Based System Applications for Guidance and Control Apr. 1991 9 p (For primary document see N91-25121 17-04)
Copyright Avail: NTIS HC/MF A12; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

07 AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxilliary power plants for aircraft.

For related information see also *20 Spacecraft Propulsion and Power, 28 Propellants and Fuels,* and *44 Energy Production and Conversion.*

N91-25147*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
A SIMULATION STUDY OF TURBOFAN ENGINE DETERIORATION ESTIMATION USING KALMAN FILTERING TECHNIQUES
Heather H. Lambert Jun. 1991 47 p
(NASA-TM-104233; H-1616; NAS 1.15:104233) Avail: NTIS HC/MF A03 CSCL 21E

Deterioration of engine components may cause off-normal engine operation. The result is an unecessary loss of performance, because the fixed schedules are designed to accommodate a wide range of engine health. These fixed control schedules may not be optimal for a deteriorated engine. This problem may be solved by including a measure of deterioration in determining the control variables. These engine deterioration parameters usually cannot be measured directly but can be estimated. A Kalman filter design is presented for estimating two performance parameters that account for engine deterioration: high and low pressure turbine delta efficiencies. The delta efficiency parameters model variations of the high and low pressure turbine efficiencies from nominal values. The filter has a design condition of Mach 0.90, 30,000 ft altitude, and 47 deg power level angle (PLA). It was evaluated using a nonlinear simulation of the F100 engine model derivative (EMD) engine, at the design Mach number and altitude over a PLA range of 43 to 55 deg. It was found that known high pressure turbine delta efficiencies of -2.5 percent and low pressure turbine delta efficiencies of -1.0 percent can be estimated with an accuracy of + or - 0.25 percent efficiency with a Kalman filter. If both the high and low pressure turbine are deteriorated, the delta efficiencies of -2.5 percent to both turbines can be estimated with the same accuracy. Author

N91-25148*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THE DESIGN/ANALYSIS OF FLOWS THROUGH TURBOMACHINERY: A VISCOUS/INVISCID APPROACH
D. P. Miller and D. R. Reddy (Sverdrup Technology, Inc., Brook Park, OH.) 1991 12 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; sponsored by AIAA, SAE, ASME, and the American Society for Electrical Engineers
(NASA-TM-104447; E-6288; NAS 1.15:104447; AIAA-91-2010)
Avail: NTIS HC/MF A03 CSCL 21E

The development of a design/analysis flow solver at NASA Lewis Research Center is discussed. The solver is axisymmetric and can be run inviscidly with assumed or calculated blockages, or with the viscous terms computed. The blade forces for each blade row are computed from blade-to-blade solutions, correlated data or force model, or from a full three dimensional solution. Codes currently under development can be separated into three distinct elements: the turbomachinery interactive grid generator energy distribution restart code (TIGGERC), the interactive blade element geometry generator (IBEGG), and the viscous/inviscid multi-blade-row average passage flow solver (VIADAC). Several experimental test cases were run to validate the VIADAC code. The tests, representative of typical axial turbomachinery duct axisymmetric wind tunnel body problems, were conducted on an SR7 Spinner axisymmetric body, a NASA Rotor 67 Fan test bed, and a transonic boatail body. The results show the computations to be in good agreement with test data. L.K.S.

N91-25149# National Aerospace Lab., Tokyo (Japan).
AN EXPERIMENT ON IGNITION IN A RECTANGULAR CROSS SECTION SCRAMJET COMBUSTOR
Kenji Kudo, Tomoyuki Komuro, Goro Masuya, Atsuo Murakami, Kouichiro Tani, Yoshio Wakamatsu, Takeshi Kanda, and Nobuo Chinzei Sep. 1990 17 p In JAPANESE; ENGLISH summary
(NAL-TR-1080; ISSN-0389-4010) Avail: NTIS HC/MF A03

Autoignition and plasma-torch forced-ignition of hydrogen in a scramjet combustor were examined using a direct-connect test apparatus with various fuel injection patterns. A new plasma torch with a feed stock of air or oxygen was developed, which is desirable for a spaceplane from the viewpoint of total system design. It is shown that the effectiveness of an air or oxygen plasma torch was comparable to that of nitrogen or argon-hydrogen plasma torch. A single plasma torch on a wall was able to ignite all the fuel jets injected from the same wall, but failed to ignite those from the opposite wall. Author

N91-25150# Oak Ridge National Lab., TN.
FIBER-SENSOR DESIGN FOR TURBINE ENGINES
K. W. Tobin, Jr., D. L. Beshears, B. W. Noel, W. D. Turley, and W. Lewis, III 1991 13 p Presented at the 5th Annual Fiber Optics Review Conference, Blacksburg, 1-4 Apr. 1991
(Contract DE-AC05-84OR-21400)
(DE91-010787; CONF-9104214-1) Avail: NTIS HC/MF A03

Turbine engine systems present a challenging environment for applications of fiber-optic-based probes and sensors. High temperatures, large vibrations, strong black-body emission backgrounds, and optical path haziness, represent some of the obstacles that characterize these environments. This paper discusses the design philosophy and implementation of a

fluorescence-based, extrinsic, fiber-optic sensor. This technique utilizes the temperature-dependent fluorescent emission of a ceramic phosphor coating to discern the temperature of the interrogated surface. Surface temperature measurements to 1500 K are achievable in the combustion environment using these methods. DOE

08 AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

For related information see also *05 Aircraft Design, Testing and Performance.*

N91-25151*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DEVELOPMENT OF AN ADAPTIVE FAILURE DETECTION AND IDENTIFICATION SYSTEM FOR DETECTING AIRCRAFT CONTROL ELEMENT FAILURES
W. Thomas Bundick [1990] 150 p Sponsored in part by Planning Research Corp., Hampton, VA
(NASA-TP-3051; L-16801; NAS 1.60:3051) Avail: NTIS HC/MF A07 CSCL 01C

A methodology for designing a failure detection and identification (FDI) system to detect and isolate control element failures in aircraft control systems is reviewed. An FDI system design for a modified B-737 aircraft resulting from this methodology is also reviewed, and the results of evaluating this system via simulation are presented. The FDI system performed well in a no-turbulence environment, but it experienced an unacceptable number of false alarms in atmospheric turbulence. An adaptive FDI system, which adjusts thresholds and other system parameters based on the estimated turbulence level, was developed and evaluated. The adaptive system performed well over all turbulence levels simulated, reliably detecting all but the smallest magnitude partially-missing-surface failures. Author

N91-25139# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
A KNOWLEDGE-BASED SYSTEM DESIGN/INFORMATION TOOL FOR AIRCRAFT FLIGHT CONTROL SYSTEMS
Dale A. Mackall and James G. Allen (Draper, Charles Stark Lab., Inc., Cambridge, MA) *In* AGARD, Knowledge Based System Applications for Guidance and Control Apr. 1991 14 p (For primary document see N91-25121 17-04)
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09 RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.

For related information see also *14 Ground Support Systems and Facilities (Space).*

N91-25152# Federal Aviation Administration, Atlantic City, NJ.
AIRPORT CAPACITY AND DELAY ANALYSES
Douglas Baart, Helen Monk, and Mary L. Schweiker Apr. 1991 19 p
(DOT/FAA/CT-TN91/18) Avail: NTIS HC/MF A03

The benefits achievable in terms of reduced delay and capacity gained at several major airports if products of the Wake Vortex Program were implemented resulting in reduced intrail separation standards is addressed. These theoretical separation standards were developed from products of the Wake Vortex Program and were used in a simulation of runway operations at John F. Kennedy (JFK), Boston (BOS), and St. Louis (STL) airports. These products include Vortex Advisory System (VAS), Wake Vortex Avoidance System (WVAS), Wake Vortex Detection/Monitoring System. In addition to site specific airports, generic runway configurations were explored as a means of grouping many airports with similar configurations. The estimates derived include delay time saved in dollars per day and capacity gained in operations per hour for each airport evaluated. Considerable benefits to the airlines and the economy could be achieved if these wake vortex products were implemented resulting in reduced separation standards. Author

N91-25153# Federal Aviation Administration, Atlantic City, NJ.
DEMONSTRATION PRECISION RUNWAY MONITOR (PRM) PROOF OF PERFORMANCE TEST RESULTS
Charles Dudas and Ricardo Astillero Jul. 1991 52 p
(DOT/FAA/CT-TN91/3) Avail: NTIS HC/MF A04

Summarized here is the Federal Aviation Administration's participation in the Demonstration Precision Runway Monitor (Demo PRM) Proof of Performance (POP) test program throughout the early summer of 1990. The system was designed to demonstrate the feasibility of providing faster and more accurate surveillance of aircraft on instrument landing approaches. The system incorporates high resolution displays with specific blunder alarms. The system utilizes a phased array antenna to enable faster update rates than the current rotating antennas. It is hoped that a system with these capabilities will allow an increase in airport runway capacity by allowing simultaneous, independent Instrument Flight Rule (IFR) approaches to parallel runways with less than 4300 feet of separation. The results of the test plan are given. Author

N91-25154# Federal Aviation Administration, Cambridge, MA.
UNIFIED METHODOLOGY FOR AIRPORT PAVEMENT ANALYSIS AND DESIGN. VOLUME 1: STATE OF THE ART Final Report, Jan. 1989 - Jan. 1990
John P. Zaniewski (Arizona State Univ., Tempe.) Jun. 1991 137 p
(DOT/FAA/RD-91/15-Vol-1; DOT-VNTSC-FA1J1-91-7-Vol-1)
Avail: NTIS HC/MF A07

An assessment of the state of the art of airport pavement analysis and design is presented. The objective is to identify those areas in current airport pavement analysis methodology that need to be substantially improved from the perspective of airport pavement design and management needs. The foundations of current design practice are examined with emphasis on the last twenty years of research and advancement in the area of pavement response prediction and cross section/layer thickness design. A review is presented of empirical methods of design for rigid and flexible pavement design, and quasi-mechanistic analyses that are based on layered-elastic theory or finite element methods. Weakness of current methods as applied to airport operational needs are discussed. A rational argument is presented for developing a unified pavement analysis and design procedure that can be used for pavements of any material type and that are based on mathematical formulations of the actual stress/strain response processes in airport pavement materials. Author

N91-25155*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
DYNAMIC TESTER FOR ROTOR SEALS AND BEARINGS Patent Application
George L. VonPragenau, inventor (to NASA) 1 Apr. 1991 14 p
(NASA-Case-MFS-28493-1; NAS 1.71:MFS-28493-1;
US-Patent-Appl-SN-678780) Avail: NTIS HC/MF A03 CSCL 14B

A dynamic tester for testing vibration damping seals and bearings is constructed having a hollow shaft extending through the seal or bearing, with the shaft internally supported at each end by fluid bearings on hollow bosses connected to an interior of an enclosure, with no rolling members connected to the shaft is described. A high pressure working fluid is forced through the hollow bosses to operate the bearings. Additionally, the shaft is provided with a reaction turbine that angularly vents a portion of

the high pressure working fluid in order to rotate the shaft at high speed, up to 40,000 rpm. The seal or bearing is mounted in a bushing, in turn supported by rods to a shaking device that vibrates the seal or bearing as the shaft is rotated. A plurality of proximity sensors are mounted from outside the enclosure to sense shaft and seal bushing vibrations, and a plurality of pressure ports are disposed in the enclosure to allow sensing of dynamic and static pressures of the testing apparatus. NASA

12 ASTRONAUTICS (GENERAL)

For extraterrestrial exploration see *91 Lunar and Planetary Exploration.*

N91-25156*# Cockerham (John M.) and Associates, Inc., Huntsville, AL.
THERMAL CONTROL SURFACES EXPERIMENT: INITIAL FLIGHT DATA ANALYSIS Final Report
Donald R. Wilkes and Leigh L. Hummer Jun. 1991 123 p Prepared in cooperation with AZ Technology, Huntsville, AL (Contract NAS8-36289)
(NASA-CR-188600; NAS 1.26:188600) Avail: NTIS HC/MF A06 CSCL 22A

The behavior of materials in the space environment continues to be a limiting technology for spacecraft and experiments. The thermal control surfaces experiment (TCSE) aboard the Long Duration Exposure Facility (LDEF) is the most comprehensive experiment flown to study the effects of the space environment on thermal control surfaces. Selected thermal control surfaces were exposed to the LDEF orbital environment and the effects of this exposure were measured. The TCSE combined in-space orbital measurements with pre and post-flight analyses of flight materials to determine the effects of long term space exposure. The TCSE experiment objective, method, and measurements are described along with the results of the initial materials analysis. The TCSE flight system and its excellent performance on the LDEF mission is described. A few operational anomalies were encountered and are discussed. Author

N91-25244*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
A FIGURE-OF-MERIT APPROACH TO EXTRATERRESTRIAL RESOURCE UTILIZATION
K. Ramohalli and T. Kirsch *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 16 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 22A

N91-26062*# Martin Marietta Corp., Denver, CO. Astronautics Group.
SURVEY OF RESOURCE OPPORTUNITIES AND CRITICAL EVALUATION OF ECONOMIC REQUIREMENTS Abstract Only
Benton C. Clark *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 24 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 22A

N91-26088*# Arizona Univ., Tucson.
COMPARATIVE ECONOMICS OF SPACE RESOURCE UTILIZATION Abstract Only
Andrew Hall Cutler *In its* Resources of Near-Earth Space: Abstracts 1991 p 37 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 22A

13 ASTRODYNAMICS

Includes powered and free-flight trajectories; and orbital and launching dynamics.

N91-25157 Aston Univ., Birmingham (England).
PRECISE ORBIT DETERMINATION AND ANALYSIS FROM SATELLITE ALTIMETRY AND LASER RANGING (APPLICATION OF SEASAT DATA TO ATMOSPHERIC DENSITY EVALUATION) Ph.D. Thesis
Derek Anthony Rothwell 1989 320 p
Avail: Univ. Microfilms Order No. BRDX91659

For optimum utilization of satellite-borne instrumentation, it is necessary to know precisely the orbital position of the spacecraft. The objectives are: (1) to derive precise orbits with particular emphasis placed on the altimeter satellite SEASAT; and (2) to utilize the precise orbits, to improve upon atmospheric density determinations for satellite drag modelling purposes. The section on precise orbit determinations is particularly concerned with the tracking data (satellite laser ranging, altimetry, and crossover height differences) and how this data can be used to analyze errors in the orbit, the geoid, and sea-surface topography. The outcome of this analysis is the determination of a low degree and order model for sea surface topography. The second section mainly concentrates on using the laser data to analyze and improve upon current atmospheric density models. In particular, the modeling of density changes associated with geomagnetic disturbances comes under scrutiny in this section. By introducing persistence modeling of a geomagnetic event and solving for certain geomagnetic parameters, a new density model is derived which performs significantly better than the state of the art models over periods of severe geomagnetic storms at SEASAT heights. This is independently verified by application of the derived model to STARLETTE orbit determinations. Dissert. Abstr.

14 GROUND SUPPORT SYSTEMS AND FACILITIES (SPACE)

Includes launch complexes, research and production facilities; ground support equipment, e.g., mobile transporters; and simulators.

For related information see also *09 Research and Support Facilities (Air).*

No abstracts in this category.

15 LAUNCH VEHICLES AND SPACE VEHICLES

Includes boosters; operating problems of launch/space vehicle systems; and reusable vehicles.

For related information see also *20 Spacecraft Propulsion and Power.*

N91-25158*# Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.
TIME-DOMAIN FINITE ELEMENTS IN OPTIMAL CONTROL WITH APPLICATION TO LAUNCH-VEHICLE GUIDANCE PhD. Thesis
Robert R. Bless Washington NASA May 1991 225 p (Grant NAG1-939)
(NASA-CR-4376; NAS 1.26:4376) Avail: NTIS HC/MF A10 CSCL 22B

A time-domain finite element method is developed for optimal control problems. The theory derived is general enough to handle a large class of problems including optimal control problems that are continuous in the states and controls, problems with discontinuities in the states and/or system equations, problems

with control inequality constraints, problems with state inequality constraints, or problems involving any combination of the above. The theory is developed in such a way that no numerical quadrature is necessary regardless of the degree of nonlinearity in the equations. Also, the same shape functions may be employed for every problem because all strong boundary conditions are transformed into natural or weak boundary conditions. In addition, the resulting nonlinear algebraic equations are very sparse. Use of sparse matrix solvers allows for the rapid and accurate solution of very difficult optimization problems. The formulation is applied to launch-vehicle trajectory optimization problems, and results show that real-time optimal guidance is realizable with this method. Finally, a general problem solving environment is created for solving a large class of optimal control problems. The algorithm uses both FORTRAN and a symbolic computation program to solve problems with a minimum of user interaction. The use of symbolic computation eliminates the need for user-written subroutines which greatly reduces the setup time for solving problems. Author

N91-25159*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THERMAL PERFORMANCE OF A LIQUID HYDROGEN TANK MULTILAYER INSULATION SYSTEM AT WARM BOUNDARY TEMPERATURES OF 630, 530, AND 152 R
Robert J. Stochl and Richard H. Knoll 1991 21 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; sponsored by AIAA, SAE, ASME, and the American Society for Electrical Engineers
(NASA-TM-104476; E-6323; NAS 1.15:104476; AIAA-91-2400)
Avail: NTIS HC/MF A03 CSCL 22B

The results are presented of a study conducted to obtain experimental heat transfer data on a liquid hydrogen tank insulated with 34 layers of MLI (multilayer insulation) for warm side boundary temperatures of 630, 530, and 150 R. The MLI system consisted of two blankets, each blanket made up of alternate layers of double silk net (16 layers) and double aluminized Mylar radiation shields (15 layers) contained between two cover sheets of Dacron scrim reinforced Mylar. The insulation system was designed for and installed on a 87.6 in diameter liquid hydrogen tank. Nominal layer density of the insulation blankets is 45 layers/in. The insulation system contained penetrations for structural support, plumbing, and electrical wiring that would be representative of a cryogenic spacecraft. The total steady state heat transfer rates into the test tank for shroud temperatures of 630, 530, 152 R were 164.4, 95.8, and 15.9 BTU/hr respectively. The noninsulation heat leaks into the tank (12 fiberglass support struts, tank plumbing, and instrumentation lines) represent between 13 to 17 pct. of the total heat input. The heat input values would translate to liquid H2 losses of 2.3, 1.3, and 0.2 pct/day, with the tank held at atmospheric pressure. Author

16 SPACE TRANSPORTATION

Includes passenger and cargo space transportation, e.g., shuttle operations; and space rescue techniques.

For related information see also *03 Air Transportation and Safety* and *18 Spacecraft Design, Testing and Performance.* For space suits see *54 Man/System Technology and Life Support.*

No abstracts in this category.

17 SPACE COMM., SPACECRAFT COMM., COMMAND & TRACKING

Includes telemetry; space communications networks; astronavigation and guidance; and radio blackout.

For related information see also *04 Aircraft Communications and Navigation* and *32 Communications and Radar.*

N91-25918*# Clemson Univ., SC. Dept. of Electrical and Computer Engineering.
TRANSPORTABLE TELEMETRY WORKSTATION Abstract Only
Aaron S. Collins *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 14 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 09F

18 SPACECRAFT DESIGN, TESTING AND PERFORMANCE

Includes satellites; space platforms; space stations; spacecraft systems and components such as thermal and environmental controls; and attitude controls.

For life support systems see *54 Man/System Technology and Life Support.* For related information see also *05 Aircraft Design, Testing and Performance, 39 Structural Mechanics,* and *16 Space Transportation.*

N91-25160# Techno-Sciences, Inc., Greenbelt, MD.
NONLINEAR DYNAMICS AND CONTROL OF FLEXIBLE STRUCTURES Final Report, 1 Sep. 1987 - 31 Aug. 1990
W. H. Bennett, H. G. Kwatny, G. L. Blankenship, O. Akhrif, and C. LaVigna 10 Oct. 1990 142 p
(Contract F49620-87-C-0103)
(AD-A232795; TSI-90-10-10-WB; AFOSR-91-0051TR) Avail: NTIS HC/MF A07 CSCL 22/2

Basic system requirements for space-based directed energy weapons will require unprecendented levels of control system performance to achieve slewing maneuvers for rapid retargeting and precision alignment of structural components supporting optical system components. Rapid, multiaxis slewing maneuvers will excite multibody dynamics involving nonlinear interactions with structural flexure. Advanced methods of modeling multibody systems with structural flexure are described and several issues in modeling slewing and pointing maneuvers for multibody systems are discussed based on Lagrange's method. Advanced methods in nonlinear control system design based on dynamic inversion by feedback linearization are then applied to a generic model of a Space Based Laser system. Connections with methods of sliding mode control are described along with practical aspects of implementation. Reduced order modeling issues and implementation of feedback linearizing control for robust stabilization are described. Experiments are outlined for validation and demonstration of critical aspects of nonlinear control for rapid, large angle slewing and precision pointing. GRA

N91-25161*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PRELIMINARY THERMAL DESIGN OF THE COLD-SAT SPACECRAFT
Hugh Arif 1991 39 p Presented at the 26th Thermophysics Conference, Honolulu, HI, 24-26 Jun. 1991; sponsored by AIAA
(NASA-TM-104440; E-6247; NAS 1.15:104440; AIAA-91-1305)
Copyright Avail: NTIS HC/MF A03 CSCL 22B

The COLD-SAT free-flying spacecraft was to perform experiments with LH2 in the cryogenic fluid management technologies of storage, supply and transfer in reduced gravity. The Phase A preliminary design of the Thermal Control Subsystem (TCS) for the spacecraft exterior and interior surfaces and components of the bus subsystems is described. The TCS was composed of passive elements which were augmented with

heaters. Trade studies to minimize the parasitic heat leakage into the cryogen storage tanks are described. Selection procedure for the thermally optimum on-orbit spacecraft attitude was defined. TRASYS-2 and SINDA'85 verification analysis was performed on the design and the results are presented. Author

N91-25162 Auburn Univ., AL.
A MULTIOBJECTIVE CONTROL SYNTHESIS FOR ARTICULATED SPACE STRUCTURES Ph.D. Thesis
Norman George Fitz-Coy 1990 149 p
Avail: Univ. Microfilms Order No. DA9109060

A method for determining closed-loop control strategies which exploit the natural characteristics of the system being controlled by dividing the overall control task into subsets, was developed and utilized to control articulated space structures. The control strategy is based on the solution to a two-player, nonzero-sum, linear quadratic, time-invariant, infinite horizon, differential game obtained using a Nash solution strategy. The closed-loop control strategy is determined by the solution to a set of coupled algebraic Riccati equations. An algorithm based on a Newton-Raphson-Kantorovich iterative procedure was developed to solve the system of coupled nonlinear equations. Intermediate sets of equations which must be solved in the iterative procedure are of a coupled Lyapunov form. These equations are solved by transforming them into a set of uncoupled, linear algebraic equations using properties of the Kronecker product. This transformation exploits the symmetric property of a Riccati matrix, so that the iterative algorithm deals with n(exp 2) + n equations instead of the 2(n exp 2) equations which would be required for a general nth order system. Several closed-loop scenarios for articulated space structures performing conflicting controlled tasks were simulated. For each scenario, time histories of the motion of the articulated systems were obtained using the new control strategy and a comparable linear quadratic regulator (LQR) strategy. In each case, the use of the new control strategy resulted in better performance than the LQR strategy. Studies were also conducted to investigate the effects of the cross-coupling weights on the control strategy. Best results were obtained when the cross-coupling weights precisely conveyed the strategy of each controller to the other. Dissert. Abstr.

N91-25163 Stanford Univ., CA.
CONTROL OF A TETHERED ARTIFICIAL GRAVITY SPACECRAFT Ph.D. Thesis
John Motley Wilson 1990 196 p
Avail: Univ. Microfilms Order No. DA9108921

Human endurance in space is currently limited by physiological changes due to weightlessness that can be debilitating and dangerous upon reentry into an environment with gravity. The only countermeasure currently known that can completely prevent this physiological deconditioning is the elimination of weightlessness itself via artificial gravity. It is possible to produce an Earth-like artificial gravity environment in a habitat module simply by connecting it to a counterweight with a long tether and slowly rotating the entire configuration. This results in a level of artificial gravity sufficient to eliminate all physiological deconditioning without exposing the inhabitants to rotation rates sufficient to induce motion sickness. This research focuses on the dynamics and control of such a tethered artificial gravity spacecraft, particularly during the spinup maneuver to achieve the desired configuration rotation rate. A laboratory model was used to investigate the dynamics of such a system in two dimensions. The hardware model consists of two free-floating modules supported on gas bearings and connected to one another with a lightweight tether. Each module is equipped with sensors, an onboard computer and cold gas thrusters for spinup and module attitude control. Experiments have demonstrated the natural motions of this system during spinup and the use of reaction jets to provide active module attitude control for improved performance. Results from the laboratory were used to validate a computer simulation for predicting the three-dimensional motions of a full size tethered artificial gravity spacecraft. Simulation results show that very massive tethers can produce disturbance torques that significantly alter the module attitude dynamics. The tether lateral oscillations caused by the spinup maneuver and the resultant disturbance torques on the modules can be decreased by substantially increasing the time taken to spin up the configuration to the desired rotation rate. Even for a very massive tether, it is possible to spin up slowly enough so that regulation of the module attitudes to within 2 degrees of their equilibrium orientation for all times during and subsequent to spinup can be achieved by limited use of reaction jets to provide control torques during the spinup period alone. Dissert. Abstr.

N91-25164 Maryland Univ., College Park.
FEEDBACK STABILIZATION VIA CENTER MANIFOLD REDUCTION WITH APPLICATION TO TETHERED SATELLITES Ph.D. Thesis
Der-Cherng Liaw 1990 223 p
Avail: Univ. Microfilms Order No. DA9110326

Center manifold reduction has recently been introduced as a tool for design of stabilizing control laws for nonlinear systems in critical cases. Here, the center manifold approach is elaborated for general such non-linear systems in several critical cases of interest, and the results are applied to the control of tethered satellite systems (TSS). In addition, to address stability questions for satellite deployment via TSS, the authors obtain new results in finite-time stability theory. The critical cases considered in the general feedback stabilization studies include the cases in which the system linearization possesses a simple zero eigenvalue (of multiplicity one or two), a pair of simple pure imaginary eigenvalues, one zero eigenvalues along with a pair of simple pure eigenvalues, and two pairs of simple pure imaginary eigenvalues. The calculations involve center manifold reduction, normal form transformations, and Liapunov function construction for critical systems. These calculations are explicit. The tethered satellite systems considered here consist of a satellite and subsatellite connected by a tether, in orbit around the Earth. The Lagrangian formulation of dynamics is used to obtain a nonlinear system of ordinary differential equations for TSS dynamics. For simplicity, a rigid, massless tether is assumed. Linear analysis reveals the presence of critical eigenvalues in the station-keeping mode of operation. This renders useful results on stabilization in critical cases to this application. The control variable assumed is tether tension feedback. Besides the design of stabilizing station-keeping controllers, stability of deployment and instability of retrieval are also shown for a constant angle deployment/retrieval scheme. Dissert. Abstr.

N91-25165*# National Inst. of Standards and Technology, Gaithersburg, MD. Building and Fire Research Lab.
MATERIAL FLAMMABILITY TEST ASSESSMENT FOR SPACE STATION FREEDOM
T. J. Ohlemiller and K. M. Villa Jun. 1991 78 p Sponsored by NASA. Lewis Research Center
(NASA-CR-187115; NAS 1.26:187115; NISTIR-4591) Avail: NTIS HC/MF A05 CSCL 22B

The NASA Upward Flame Propagation test, which measures response to a well-defined laminar flame at the bottom of a test sample, is currently used to screen for flammability all materials intended for use in the interior of manned spacecraft. The response of a series of materials was compared in this test and in the standard NIST flammability tests. A simplified upward flame spread model, which utilizes inputs derived from the NIST test, was employed in an attempt to predict the behavior in the modified NASA tests. Author

N91-25166# Los Alamos National Lab., NM.
DISTRIBUTED SPACE PLATFORMS FOR REMOTE SENSING
G. H. Canavan Apr. 1991 17 p
(Contract W-7405-eng-36)
(DE91-011047; LA-11879-MS) Avail: NTIS HC/MF A03

Uses of space for information, communication, and sensing will continue to grow. In many cases, the U.S. has no alternative means of measurement. They are well suited to tracing pollution and making meteorological measurements, which, like the satellites,

have no regard for international boundaries. Technical challenges are significant, but sensors for high spatial and temporal resolution measurements of meteorology, climate, and pollution could be available when needed, if development is started soon. DOE

N91-25167*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
THERMALLY ISOLATED DEPLOYABLE SHIELD FOR SPACECRAFT Patent Application
John W. Redmon, Jr., inventor (to NASA), Andre E. Miller, inventor (to NASA), Bobby E. Lawson, inventor (to NASA), and William E. Cobb, inventor (to NASA) 18 Apr. 1991 25 p
(NASA-Case-MFS-28524-1; NAS 1.71:MFS-28524-1; US-Patent-Appl-SN-691610) Avail: NTIS HC/MF A03 CSCL 22B

A thermally isolated deployable shield for spacecraft is provided utilizing a plurality of lattice panels stowable generally against the craft and deployable to some fixed distance from the craft. The lattice panels are formed from replaceable shield panels affixed to lattice structures. The lattice panels generally encircle the craft providing 360 degree coverage therearound. Actuation means are provided from translating the shield radially outward from the craft and thermally isolating the shield from the craft. The lattice panels are relatively flexible, allowing the shield to deploy to variable diameters while retaining uniform curvature thereof. Restraining means are provided for holding the shield relatively tight in its stowed configuration. Close-out assemblies provide light sealing and protection of the annular spaces between the deployed shield and the crafts end structure. NASA

N91-25168*# McDonnell-Douglas Space Systems Co., Huntsville, AL.
CONTROL AND STRUCTURAL OPTIMIZATION FOR MANEUVERING LARGE SPACECRAFT Final Report
H. M. Chun, J. D. Turner, and C. C. Yu Oct. 1990 86 p Prepared in cooperation with Photon Research Associates, Inc., Cambridge, MA
(Contract NAS1-18763)
(NASA-CR-187490; NAS 1.26:187490) Avail: NTIS HC/MF A05 CSCL 22B

Presented here are the results of an advanced control design as well as a discussion of the requirements for automating both the structures and control design efforts for maneuvering a large spacecraft. The advanced control application addresses a general three dimensional slewing problem, and is applied to a large geostationary platform. The platform consists of two flexible antennas attached to the ends of a flexible truss. The control strategy involves an open-loop rigid body control profile which is derived from a nonlinear optimal control problem and provides the main control effort. A perturbation feedback control reduces the response due to the flexibility of the structure. Results are shown which demonstrate the usefulness of the approach. Software issues are considered for developing an integrated structures and control design environment. Author

19 SPACECRAFT INSTRUMENTATION

For related information see also *06 Aircraft Instrumentation* and *35 Instrumentation and Photography.*

N91-25169# Los Alamos National Lab., NM.
TWO SENSORS FOR DISTRIBUTED SATELLITE PLATFORMS
G. H. Canavan Apr. 1991 13 p
(Contract W-7405-eng-36)
(DE91-011051; LA-11861-MS) Avail: NTIS HC/MF A03

Sensors are well suited to deployment on highly-proliferated satellite platforms like singlet space-based interceptors (SBIs). Proliferated radars could achieve useful search rates. The simplest could be little more than altimeters that looked directly below to provide a continuous fence against low-flying aircraft. Mounting them on the SBI lifejackets should be inexpensive. Bus watching is a rough alternative to discrimination. Proliferation could allow multiple sensors to observe buses above the horizon at close ranges. DOE

20 SPACECRAFT PROPULSION AND POWER

Includes main propulsion systems and components, e.g., rocket engines; and spacecraft auxilliary power sources.

For related information see also *07 Aircraft Propulsion and Power, 28 Propellants and Fuels, 44 Energy Production and Conversion,* and *15 Launch Vehicles and Space Vehicles.*

N91-25170# Edgerton, Germeshausen and Grier, Inc., Idaho Falls, ID.
FISSION FRAGMENT ROCKET SCIENTIFIC FEASIBILITY ASSESSMENT
B. G. Schnitzler, J. L. Jones, and G. F. Chapline Jun. 1989 71 p
(Contracts DE-AC07-76ID-01570; W-7405-eng-48)
(DE91-010076; EGG-NERD-8585) Avail: NTIS HC/MF A04

A new reactor concept which has the potential of enabling extremely energetic and ambitious space propulsion mission into near interstellar space is described. Fission fragments are directly used as the propellant by guiding them out of a very low density core using magnetic fields. The very high fission fragment velocities correspond to specific impulses of about 10 million m/s. Configurations capable of using about 30 pct. of the fission fragment kinetic energy yield specific impulses of about three million m/s. Results of preliminary scientific feasibility assessments focused on reactor physics, thermal management, and fission fragments extraction are reported. Comparisons of engine performance potential and requirements for Alpha Centauri and TAU (thousand astronomical units) missions are presented. DOE

N91-25171*# Colorado State Univ., Fort Collins. Dept. of Mechanical Engineering.
ADVANCED ELECTRIC PROPULSION RESEARCH - 1990 Annual Report, 1 Jan. 1990 - 1 Jan. 1991
Jeffery M. Monheiser and Paul J. Wilbur May 1991 55 p
(Grant NGR-06-002-112)
(NASA-CR-187103; NAS 1.26:187103) Avail: NTIS HC/MF A04 CSCL 21H

An experimental study of impingement current collection on the accelerator grid of an ion thruster is presented. The equipment, instruments, and procedures being used to conduct the study are discussed. The contribution to this current due to charge-exchange ions produced close to the grid is determined using a volume-integration procedure and measured ion beam current design, computed neutral atom density and measured beam plasma potential data. This current, which is expected to be almost equal to that measured directly, is found to be an order of magnitude less. The impingement current determined by integrating the current density of ambient ions in the beam plasma close to the grid is found to agree with the directly measured impingement current. Possible reasons for the disagreement between the directly measured and volume integrated impingement currents are discussed. Author

N91-25172*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
POWER ELECTRONICS FOR LOW POWER ARCJETS
John A. Hamley and Gerald M. Hill 1991 17 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; sponsored by AIAA, SAE, ASME, and the American Society for Electrical Engineers
(NASA-TM-104459; E-6300; NAS 1.15:104459; AIAA-91-1991) Avail: NTIS HC/MF A03 CSCL 21H

In anticipation of the needs of future light-weight, low-power spacecraft, arcjet power electronics in the 100 to 400 W operating range were developed. Limited spacecraft power and thermal

control capacity of these small spacecraft emphasized the need for high efficiency. Power topologies similar to those in the higher 2 kW and 5 to 30 kW power range were implemented, including a four transistor bridge switching circuit, current mode pulse-width modulated control, and an output current averaging inductor with an integral pulse generation winding. Reduction of switching transients was accomplished using a low inductance power distribution network, and no passive snubber circuits were necessary for power switch protection. Phase shift control of the power bridge was accomplished using an improved pulse width modulation to phase shift converter circuit. These features, along with conservative magnetics designs allowed power conversion efficiencies of greater than 92.5 percent to be achieved into resistive loads over the entire operating range of the converter. Electromagnetic compatibility requirements were not considered in this work, and control power for the converter was derived from AC mains. Addition of input filters and control power converters would result in an efficiency of on the order of 90 percent for a flight unit. Due to the developmental nature of arcjet systems at this power level, the exact nature of the thruster/power processor interface was not quantified. Output regulation and current ripple requirements of 1 and 20 percent respectively, as well as starting techniques, were derived from the characteristics of the 2 kW system but an open circuit voltage in excess of 175 V was specified. Arcjet integration tests were performed, resulting in successful starts and stable arcjet operation at power levels as low as 240 W with simulated hydrazine propellants. Author

N91-25173*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

SENSIBLE HEAT RECEIVER FOR SOLAR DYNAMIC SPACE POWER SYSTEM

Marla E. Perez-Davis, James R. Gaier, and Chris Petrefski (Cleveland State Univ., OH.) 1991 6 p Presented at the 26th Intersociety Energy Conversion Engineering Conference, Boston, MA, 4-9 Aug. 1991; sponsored by the American Nuclear Society, SAE, the American Chemical Society, AIAA, ASME, IEEE, and the American Inst. of Chemical Engineers

(NASA-TM-104393; E-6208; NAS 1.15:104393) Avail: NTIS HC/MF A02 CSCL 10B

A sensible heat receiver considered in this study uses a vapor grown carbon fiber-carbon (VGCF/C) composite as the thermal storage media and was designed for a 7 kW Brayton engine. The proposed heat receiver stores the required energy to power the system during eclipse in the VGCF/C composite. The heat receiver thermal analysis was conducted through the Systems Improved Numerical Differencing Analyzer and Fluid Integrator (SINDA) software package. The sensible heat receiver compares well with other latent and advanced sensible heat receivers analyzed in other studies while avoiding the problems associated with latent heat storage salts and liquid metal heat pipes. The concept also satisfies the design requirements for a 7 kW Brayton engine system. The weight and size of the system can be optimized by changes in geometry and technology advances for this new material. Author

N91-25174*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

EXPERIMENTS WITH PHASE CHANGE THERMAL ENERGY STORAGE CANISTERS FOR SPACE STATION FREEDOM

Thomas W. Kerslake 1991 16 p Presented at the 26th Intersociety Energy Conversion Engineering Conference, Boston, MA, 4-9 Aug. 1991; sponsored by the American Nuclear Society, SAE, the American Chemical Society, AIAA, IEEE, and the American Inst. of Chemical Engineers

(NASA-TM-104427; E-6102; NAS 1.15:104427) Avail: NTIS HC/MF A03 CSCL 10C

The solar dynamic power module proposed for the growth Space Station Freedom uses the heat of fusion of a phase change material (PCM) to efficiently store thermal energy for use during eclipse periods. The PCM, a LiF-20CaF2 salt, is contained in annular, metal canisters located in a heat receiver at the focus of a solar concentrator. PCM canister ground-based experiments and analytical heat transfer studies are discussed including the hardware test procedures and test results. After more than 900 simulated Space Station Freedom orbital cycles, no canister cracks or leaks were observed and all data were successfully collected. The effect of 1-g test orientation on canister wall temperatures was generally small while void position was strongly dependent on test orientation and canister cooling. In one test orientation, alternating wall temperature data were measured and results support an earlier theory of oscillating vortex flow in the PCM melt. Analytical canister wall temperatures compared very favorably with experimental temperature data. This illustrates that ground-based canister thermal performance can be predicted well by analyses that employ straight-forward, engineering models of void behavior and liquiod PCM free convection. Because of the accuracy of analytical models and the relative insensitivity of 1-g performance to test orientation, canister performance in micro-g should be predictable with a high degree of confidence by removing gravity effects from the analytical modeling. Author

N91-25175*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

EXPERIMENTAL AND ANALYTICAL STUDIES OF FLOW THROUGH A VENTRAL AND AXIAL EXHAUST NOZZLE SYSTEM FOR STOVL AIRCRAFT

Barbara S. Esker and James R. DeBonis (Sverdrup Technology, Inc., Brook Park, OH.) 1991 20 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; sponsored by AIAA, SAE, ASME, and the American Society for Electrical Engineers

(NASA-TM-104364; E-6160; NAS 1.15:104364; AIAA-91-2135) Avail: NTIS HC/MF A03 CSCL 21H

Flow through a combined ventral and axial exhaust nozzle system was studied experimentally and analytically. The work is part of an ongoing propulsion technology effort at NASA Lewis Research Center for short takeoff, vertical landing (STOVL) aircraft. The experimental investigation was done on the NASA Lewis Powered Lift Facility. The experiment consisted of performance testing over a range of tailpipe pressure ratios from 1 to 3.2 and flow visualization. The analytical investigation consisted of modeling the same configuration and solving for the flow using the PARC3D computational fluid dynamics program. The comparison of experimental and analytical results was very good. The ventral nozzle performance coefficients obtained from both the experimental and analytical studies agreed within 1.2 percent. The net horizontal thrust of the nozzle system contained a significant reverse thrust component created by the flow overturning in the ventral duct. This component resulted in a low net horizontal thrust coefficient. The experimental and analytical studies showed very good agreement in the internal flow patterns. Author

N91-25176*# National Aeronautics and Space Administration, Washington, DC.

SPACE TRANSPORTATION PROPULSION TECHNOLOGY SYMPOSIUM. VOLUME 1: EXECUTIVE SUMMARY

May 1991 36 p Symposium held in State College, PA, 25-29 Jun. 1990

(NASA-CP-3112; NAS 1.55:3112) Avail: NTIS HC/MF A03 CSCL 21H

The Space Transportation Propulsion Technology Symposium was held to provide a forum for communication within the propulsion within the propulsion technology developer and user communities. Emphasis was placed on propulsion requirements and initiatives to support current, next generation, and future space transportation systems, with the primary objectives of discerning whether proposed designs truly meet future transportation needs and identifying possible technology gaps, overlaps, and other programmatic deficiencies. Key space transportation propulsion issues were addressed through four panels with government, industry, and academia membership. The panels focused on systems engineering and integration; development, manufacturing and certification; operational efficiency; and program development and cultural issues. Author

N91-25177 Virginia Polytechnic Inst. and State Univ., Blacksburg.
EXPERIMENTAL METHOD OF ANALYZING STRESS INTENSITY FACTORS AND SINGULARITY ORDER IN ROCKET MOTOR GEOMETRY Ph.D. Thesis
Che-Way Chang 1990 151 p
Avail: Univ. Microfilms Order No. DA9109400

A series of frozen stress experiments were conducted on surface flaws of varying aspect ratios in pressurized cylinder with a star-shaped cutout in order to study the stress intensity factor distribution along the flaw border and to estimate the loss of the inverse square root singularity when the crack border intersects the inner star surface at right angles. By applying a refined optical method, the photoelastic data are converted into classical stress intensity factors resulting from the three dimensional stress state existing at the inter surface and compared with a numerical analysis to indicate the nearly uniform distribution of the stress intensity factor along the crack border. Based upon this result, a two dimensional weight function approach is demonstrated to yield accurate values of the maximum stress intensity factor for the motor grain test geometry. Dissert. Abstr.

N91-25178*# GenCorp Aerojet, Sacramento, CA. Propulsion Div.
SENSOR DATA VALIDATION AND RECONSTRUCTION. PHASE 1: SYSTEM ARCHITECTURE STUDY Final Report, May 1990 - Feb. 1991
Jun. 1991 329 p
(Contract NAS3-25883)
(NASA-CR-187124; NAS 1.26:187124) Avail: NTIS HC/MF A15 CSCL 21H

The sensor validation and data reconstruction task reviewed relevant literature and selected applicable validation and reconstruction techniques for further study; analyzed the selected techniques and emphasized those which could be used for both validation and reconstruction; analyzed Space Shuttle Main Engine (SSME) hot fire test data to determine statistical and physical relationships between various parameters; developed statistical and empirical correlations between parameters to perform validation and reconstruction tasks, using a computer aided engineering (CAE) package; and conceptually designed an expert system based knowledge fusion tool, which allows the user to relate diverse types of information when validating sensor data. The host hardware for the system is intended to be a Sun SPARCstation, but could be any RISC workstation with a UNIX operating system and a windowing/graphics system such as Motif or Dataviews. The information fusion tool is intended to be developed using the NEXPERT Object expert system shell, and the C programming language. Author

N91-25179*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NUCLEAR ROCKET PROPULSION. NASA PLANS AND PROGRESS, FY 1991
John S. Clark and Thomas J. Miller 1991 8 p Presented at the 26th Intersociety Energy Conversion Engineering Conference, Boston, MA, 4-9 Aug. 1991; cosponsored by the ANS, SAE, ACS, AIAA, ASME, IEEE, and AIChE
(NASA-TM-104455; E-6296; NAS 1.15:104455) Avail: NTIS HC/MF A02 CSCL 21H

NASA has initiated planning for a technology development project for nuclear rocket propulsion systems for space explorer initiative (SEI) human and robotic missions to the moon and Mars. An interagency project is underway that includes the Department of Energy National Laboratories for nuclear technology development. The activities of the project planning team in FY 1990 and 1991 are summarized. The progress to date is discussed, and the project plan is reviewed. Critical technology issues were identified and include: (1) nuclear fuel temperature, life, and reliability; (2) nuclear system ground test; (3) safety; (4) autonomous system operation and health monitoring; and (5) minimum mass and high specific impulse. Author

N91-25180# National Aerospace Lab., Tokyo (Japan).
PERFORMANCE OF THE N2H4/MMH MIXED FUEL REGENERATIVELY COOLED ENGINE
Shuichi Ueda, Yukio Kuroda, Noboru Sakuranaka, Katsuto Kisaka, Hiroshi Miyajima, Katsuaki Kosaka, and Ryuichi Nagashima Sep. 1990 38 p In JAPANESE; ENGLISH summary
(NAL-TR-1082; ISSN-0389-4010) Avail: NTIS HC/MF A03

Experimental regeneratively cooled bipropellant engines, with a vacuum thrust of 2000 N at a chamber pressure of 0.98 MPa and an area ratio of 240:1, were fired with hydrazine-MMH mixed fuels to evaluate potential performance and cooling improvement. Regeneratively cooled engine tests were conducted with 80 percent hydrazine-20 percent MMH mixed fuels as well as with MMH single fuel, utilizing optimized injectors for each fuel. The chamber pressure was varied in a range from 0.6 to 0.9 MPa. Long duration firing tests of 160 seconds were conducted to evaluate heat soak back level and demonstrate safe shutdowns of a mixed fuel regeneratively cooled engine. The peak specific impulses of the mixed fuel was more than 322 seconds, while that of MMH was 308 seconds. Regenerative cooling with the mixed fuel seemed to be particularly advantageous in that the temperature increase through the cooling channels was smaller than that of MMH; this reduced performance degradation was due to reactive stream separation (blow apart) at higher chamber pressures. No indication of explosion in the coolant channels or manifolds at engine shutdown was observed during long firing tests of the improved chamber. Author

N91-25181# Technische Univ., Delft (Netherlands).
FUEL PYROLYSIS EFFECTS ON HYBRID ROCKET AND SOLID FUEL RAMJET COMBUSTOR PERFORMANCE Ph.D. Thesis
Jan-Pieter deWilde 1991 166 p Sponsored by Netherlands Foundation for Technical Research
(ISBN-90-6275-666-2; ETN-91-99431) Copyright Avail: NTIS HC/MF A08

A chemical kinetic and thermal pyrolysis model are developed to study the effects of the composition and the temperature of the pyrolysis products and the effective heat of gasification of the solid fuel on combustion characteristics. Integration of the models leads to a closed model, the so called pyrolysis model, which determines a relation between the regression rate and the pyrolysis temperature of the solid fuel. The pyrolysis model is implemented successfully in the already existing COPPEF flow and combustion model. The pyrolysis model is applied to two solid fuels, polyethylene and polymethylmethacrylate, but can be applied to any solid fuel as long as sufficient pyrolysis data is available. ESA

N91-25182*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SMALL STIRLING DYNAMIC ISOTOPE POWER SYSTEM FOR MULTIHUNDRED-WATT ROBOTIC MISSIONS
David J. Bents 1991 16 p Presented at the International Pacific Air and Space Technology Conference, Gifu City, Japan, 7-11 Oct. 1991; sponsored by the Society of Automotive Engineers, Inc.
(NASA-TM-104460; E-6301; NAS 1.15:104460) Avail: NTIS HC/MF A03 CSCL 10B

Free piston Stirling Engine (FPSE) and linear alternator (LA) technology is combined with radioisotope heat sources to produce a compact dynamic isotope power system (DIPS) suitable for multihundred watt space application which appears competitive with advanced radioisotope thermoelectric generators (RTGs). The small Stirling DIPS is scalable to multihundred watt power levels or lower. The FPSE/LA is a high efficiency convertor in sizes ranging from tens of kilowatts down to only a few watts. At multihundred watt unit size, the FPSE can be directly integrated with the General Purpose Heat Source (GPHS) via radiative coupling; the resulting dynamic isotope power system has a size and weight that compares favorably with the advanced modular (Mod) RTG, but requires less than a third the amount of isotope fuel. Thus the FPSE extends the high efficiency advantage of

dynamic systems into a power range never previously considered competitive for DIPS. This results in lower fuel cost and reduced radiological hazard per delivered electrical watt. Author

N91-25183*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
EFFECTS OF WINDBLOWN DUST ON PHOTOVOLTAIC SURFACE S ON MARS
James R. Gaier, Marla E. Perez-Davis, and Alia M. Moinuddin (Case Western Reserve Univ., Cleveland, OH.) 1991 8 p Presented at the 26th Intersociety Energy Conversion Engineering Conference, Boston, MA, 4-9 Aug. 1991; sponsored by the American Nuclear Society, SAE, the American Chemical Society, AIAA, ASME, IEEE, and the American Inst. of Chemical Engineers
(NASA-TM-104448; E-6289; NAS 1.15:104448) Avail: NTIS HC/MF A02 CSCL 10A

Photovoltaic (PV) coverslip material was subjected to Maritan dust storm conditions using basaltic dust flowing through the Martian Surface Wind Tunnel at NASA-Ames. Initially dusted and clear coverslips were held at angles from 0 to 90 deg., and the dust laden wind velocity was varied from 20 to 97 m/s. Blowing dust was found to adhere more to the coverslips as the angle was increased. However, dust was partially cleared from surfaces that were initially dusted at substantially lower velocities in dust laden wind than in clear wind. Thus, an equilibrium amount of dust accumulated which was dependent only upon angle and wind velocity and not upon initial concentration of dust. Abrasion was also evident in the coverslips. It increased with wind velocity and angle of attack. It appears that an initial dust layer may help to protect PV surfaces from abrasion. Author

N91-25184*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FULL-SIZE SOLAR DYNAMIC HEAT RECEIVER THERMAL-VACUUM TESTS
L. M. Sedgwick, K. J. Kaufmann (Boeing Aerospace and Electronics Co., Seattle, WA.), K. L. McLallin, and Thomas W. Kerslake 1991 8 p Presented at the 26th Intersociety Energy Conversion Engineering Conference, Boston, MA, 4-9 Aug. 1991; sponsored by the American Nuclear Society, SAE, the American Chemical Society, AIAA, ASME, IEEE, and the American Inst. of Chemical Engineers
(NASA-TM-104486; E-6332; NAS 1.15:104486) Avail: NTIS HC/MF A02 CSCL 10B

The testing of a full-size, 120 kW, solar dynamic heat receiver utilizing high-temperature thermal energy storage is described. The purpose of the test program was to quantify receiver thermodynamic performance, operating temperatures, and thermal response to changes in environmental and power module interface boundary conditions. The heat receiver was tested in a vacuum chamber with liquid nitrogen cold shrouds and an aperture cold plate to partly simulate a low-Earth-orbit environment. The cavity of the receiver was heated by an infrared quartz lamp heater with 30 independently controllable zones to allow axially and circumferentially varied flux distributions. A closed-Brayton cycle engine simulator conditioned a helium-xenon gas mixture to specific interface conditions to simulate the various operational modes of the solar dynamic power module on the Space Station Freedom. Inlet gas temperature, pressure, and flow rate were independently varied. A total of 58 simulated orbital cycles, each 94 minutes in duration, was completed during the test conduct period. Author

N91-26055*# Arizona Univ., Tucson. Lunar and Planetary Lab.
DEVELOPMENT OF AN ELECTROSTATIC PROPULSION ENGINE USING SUB-MICRON POWDERS AS THE REACTION MASS Abstract Only
F. Herbert and K. R. Kendall *In its* Resources of Near-Earth Space: Abstracts 1991 p 21 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

N91-26060*# Analex Corp., Cleveland, OH.
STACKING THE ODDS IN FAVOR OF A SPACE PROPULSION JACKPOT Abstract Only
Alan J. Willoughby *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 23 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

N91-26064*# General Dynamics Corp., San Diego, CA. Laser Systems Lab.
OPTIMUM ROCKET PROPULSION FOR ENERGY-LIMITED TRANSFER Abstract Only
Anthony Zuppero and Geoffrey A. Landis (Sverdrup Technology, Inc., Brook Park, OH.) *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 25 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 22H

23 CHEMISTRY AND MATERIALS (GENERAL)

N91-25185* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SUBSTITUTED 1,1,1-TRIARYL-2,2,2-TRIFLUOROETHANES AND PROCESSES FOR THEIR SYNTHESIS Patent
William B. Alston, inventor (to NASA) and Roy F. Gratz, inventor (to NASA) 30 Apr. 1991 10 p Filed 10 Oct. 1989 Division of US-Patent-Appl-SN-292049, filed 30 Dec. 1988
(NASA-Case-LEW-14345-4; US-Patent-5,011,955; US-Patent-Appl-SN-419554; US-Patent-Appl-SN-292049; US-Patent-Class-552-101; US-Patent-Class-552-108; US-Patent-Class-552-110; US-Patent-Class-552-113; US-Patent-Class-552-115; Int-Patent-Class-C07C-15/16) Avail: US Patent and Trademark Office CSCL 07A

Synthetic procedures are described for tetraalkyls, tetraacids, and dianhydrides substituted 1,1,1-triaryl-2,2,2-trifluoroethanes which comprises: (1) 1,-bis (dialkylaryl)-1-aryl-2,2,2, trifluororthane, (2) 1,1-bis(dicarboxyaryl) 1 aryl-2,2,2 trifluoroethane, or (3) cyclic dianhydride or diamine of 1,1-bis (dialkylarly) 1-aryl-2,2,2 trifluoroethanes. The synthesis of (1) is accomplished by the condensation reaction of an aryltrifluoromethyl ketone with a dialkylaryl compound. The synthesis of (2) is accomplished by oxidation of (1). The synthesis dianhydride of (3) is accomplished by the conversion of (2) to its corresponding cyclic dianhydride. The synthesis of the diamine is accomplished by the similar reaction of an aryltrifluoromethyl ketone with aniline or alkyl substituted or disubstituted anilines. Also, other derivatives of the above are formed by nucleophilic displacement reactions.
Official Gazette of the U.S. Patent and Trademark Office

24 COMPOSITE MATERIALS

Includes physical, chemical, and mechanical properties of laminates and other composite materials.
For ceramic materials see *27 Nonmetallic Materials.*

N91-25186*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
QUALITY CONTROL OF THE TRIBOLOGICAL COATING PS212
Harold E. Sliney, Christopher DellaCorte, and Daniel L. Deadmore Jun. 1989 20 p
(NASA-TM-102067; E-4824; NAS 1.15:102067) Avail: NTIS HC/MF A03 CSCL 11D

PS212 is a self-lubricating, composite coating that is applied by the plasma spray process. It is a functional lubricating coating from 25 C (or lower) to 900 C. The coating is prepared from a blend of three different powders with very dissimilar properties. Therefore, the final chemical composition and lubricating

effectiveness of the coatings are very sensitive to the process variables used in their preparation. Defined here are the relevant variables. The process and analytical procedures that will result in satisfactory tribological coatings are discussed. Author

N91-25187 Delaware Univ., Newark.
THERMAL TRANSPORT PROPERTIES OF SELECTED ADVANCED CERAMIC COMPOSITES Ph.D. Thesis
Stephen Clinton Beecher 1990 266 p
Avail: Univ. Microfilms Order No. DA9109925

The thermal conductivity (k) and the specific heat (C sub p) for two different sets of ceramic composite materials were measured in the temperature range 20 K to 300 K. The results of these measurements were analyzed using monolithic models which describe the temperature dependence of these properties and composite theory which describes their compositional dependence. The systems studied include a series of glass/alumina composites and a series of mullite/cordierite composites. The structure of both sets of materials were modified as a result of the processing conditions during the formation of the final composite and is reflected in both the temperature and compositional dependence of k and C (sub p). Results for the glass/alumina composites show the transition from amorphous to crystalline behavior, while the results for the mullite/cordierite show the formation of solid solutions. The Klemens-Callaway model was applied to the experimental results for both sets of materials. Modifications to this model were necessary in order to describe k(T) for the Glass/Alumina composites when the amount of the glass present was greater than 50 weight percent. Micrographs show that the alumina phase for those samples with greater than 70 weight percent alumina has sintered, suggesting that the compositional dependence of k might be described by a percolation model. C (sub p)(T) for the glass/alumina composites is best described by a model proposed by Hirao for glass forming compounds. This model is a modification of the Tarassov theory for polymers and chain-like structures that incorporates one and three dimensional components into the density of states. The modification includes the contributions of network modifiers, which is described by an Einstein term. The compositional dependence of C (sub p) does not follow the rule of mixtures as a result of the change in the component structure. These structural changes violate the requirement that the component C (sub p) remain unchanged. C (sub p)(T) for the mullite/cordierite composites can be described by including an Einstein term into the Debye density of states. Although single component samples were not available, the results of the compositional dependence of k suggests that the rule for C sub p might not be obeyed as a result of the change in the structure. Dissert. Abstr.

N91-25188 Rensselaer Polytechnic Inst., Troy, NY.
SELECTED PROBLEMS IN MICROMECHANICS OF FIBROUS COMPOSITES Ph.D. Thesis
Tungyang Chen 1990 258 p
Avail: Univ. Microfilms Order No. DA9111050

Micromechanical modelling procedures for prediction of overall thermomechanical behavior and local fields in unidirectional coated and uncoated fibrous composites are presented. General thermomechanical loading situations are considered. The formulation allots that the fiber could be at most cylindrically orthotropic, and the coating and matrix are transversely isotropic. Local fields of the composite are approximated through the exact solution of a single coated fiber in an infinite medium which the authors derive. Results are extended to laminated plates, consisting of two-phase unidirectional plies, subjected to in-plane loadings and uniform temperature changes. Effective thermal conductivities and local thermal intensities of such composites are also examined. The coated fiber may have an arbitrary orientation distribution. The micromechanical model employed is primarily based on the Mori-Tanaka approximation. Some new, simple formulae for the overall elastic moduli of multiphase transversely isotropic composites are derived. The inclusions considered are fibers with circular cross section and platelet-like reinforcements. Both unidirectional and completely random orientations are examined. Exact thermal expansion coefficients are found for three-phase fibrous media. Results are related to phase thermomechanical properties and overall elastic compliance only. The derivation is based on a novel decomposition procedure. Thermal effects can be uniquely expressed in terms of the solutions of mechanical loadings. Those are established for two-phase media and three-phase unidirectional fibrous composites as well as laminated plates consisting of two-phase fibrous plies. A number of exact results, e.g., the exact connections between components of mechanical influence functions for two-phase fibrous and particulate media are presented. Finally, the existence of diagonal symmetry in estimates of overall elastic moduli of heterogeneous media is examined for several micromechanical models. Bounds and positive definiteness of the elastic moduli are also described.
Dissert. Abstr.

N91-25189 Rice Univ., Houston, TX.
MODELING OF SETTING STRESSES IN PARTICLE REINFORCED POLYMER COMPOSITES USING FINITE ELEMENT ANALYSIS Ph.D. Thesis
Aladin Mohamed Boriek 1990 246 p
Avail: Univ. Microfilms Order No. DA9110949

A three-dimensional Finite Element Analysis (FEA) was used to investigate the effect of geometric arrangement of particulate reinforcement in highly filled polymer composites (such as polymer concrete) on the setting stresses that develop in these materials during cure due to resin shrinkage during polymerization. These composites were initially modeled by systems reinforced with spherical particles packed in simple cubic (SC) and face-centered cubic (FCC) arrangements within the polymer matrix. A pronounced decrease in setting stresses was observed in the FCC system, which has a greater aggregate to resin ratio and more of resin domains per unit cell. A hexagonal-close-packed arrangement of hexagonal, prism-shaped aggregate was also analyzed and found to develop higher stresses, indicating that aggregate shape has an effect on setting stresses. A second set of models investigated the effect of size gradation and geometric arrangement of spherical reinforcing particles on setting stresses. The maximum stresses occur at the particle-resin interface, underlining the importance of resin/aggregate adhesion. Reduction of setting stresses by a factor of two was observed in systems with efficient packing, achieved with proper size gradation and close-packed geometry. A microstructural model for a polymer composite system based on a fairly random arrangement (FRA) of aggregate particles was also developed. This model gives a realistic representation of actual particle reinforced polymer composites. FEA results were used to develop an empirical equation for maximum setting stresses for particle reinforced polymer composites. An understanding of setting stress distribution in polymer composites is provided. Guidelines are given for optimizing the amount, shape and particle size distribution of the reinforcing aggregate in polymer composites so as to minimize setting stresses, thus leading to composites with significantly enhanced strength. Dissert. Abstr.

N91-25190 Delaware Univ., Newark.
COMPRESSION RESPONSE OF THICK-SECTION COMPOSITE MATERIALS Ph.D. Thesis
Eugene Thomas Camponeschi, Jr. 1990 293 p
Avail: Univ. Microfilms Order No. DA9109934

The compression response of composite materials between 0.25 and 1.0 in. thick is examined. The effect of thickness on the elastic properties, strength, and failure mechanisms in carbon and fiberglass reinforced composite materials was determined. The 48, 96, and 192 ply (0.25, 0.50, and 1.0 in.) thick AS4/3501-6 and S2/3501-6 panels were fabricated with unidirectional and (O2/90)(sub ns) stacking sequences. A compression test method was designed that allowed the evaluation of these materials in compression. Inplane and through-thickness properties are reported. Fractography and high-speed video recordings were used to interrogate the failure mechanisms of the thick materials considered. The inplane moduli, inplane and through-thickness Poisson's ratios, compression strength, and failure mechanisms were all shown to be independent of material thickness. The inplane

and through-thickness elastic properties of the (O2/90)(sub ns) laminates were accurately predicted form measured 3-D lamina properties using an exact 3-D theoretical solution for effective laminate properties. The effect of fixture imposed through-thickness restraint on laminate failure was theoretically documented.
Dissert. Abstr.

N91-25191 Iowa State Univ. of Science and Technology, Ames.
ULTRASONIC CHARACTERIZATION OF ELASTIC CONSTANTS AND DEFECTS IN COMPOSITE MATERIALS Ph.D. Thesis
Hyunjo Jeong 1990 145 p
Avail: Univ. Microfilms Order No. DA9110512

Anisotropic elastic constants were determined for silicon carbide particulate (SiC sub p) reinforced Al matrix composites using ultrasonic velocity measurements. The composite materials, fabricated in the form of plates by a power metallurgy extrusion process, included 2124, 6061 and 7091 Al alloy reinforced by 10 to 30 percent by volume of alpha-SiC(sub p). A theoretical model based on the Eshelby's method and Mori-Tanaka's theory was used to predict the elastic constants of the Al/SiC(sub p) composites. A 6 x 6 matrix form of effective stiffness expression was developed to investigate the effect of particle characteristics on the anisotropic properties. Ultrasonically measured constants were compared with both the tensile test data and the model prediction. Theoretical and experimental studies of the ultrasonic velocity for the nondestructive evaluation of porosity in carbon fiber reinforced plastics (CFRP) were performed. A fiber reinforced composite containing voids was used to study the effect of void characteristics and fiber properties on the ultrasonic velocity propagating normal to the fiber. Ultrasonic spectroscopy was employed to measure the phase velocity and the attenuation in a through transmission, immersion testing mode. The composite materials studied include carbon (graphite) fiber reinforced epoxy and polyimide laminates containing different level of porosity. The relationship between ultrasonic attenuation and velocity dispersion was tested using the local approximation of the exact Kramers-Kronig relation. Dissert. Abstr.

N91-25192 City Univ. of New York, NY.
INTEGRAL FORMULATIONS WITH SPECIAL KERNELS FOR A COMPOSITE PANEL WITH AN ELLIPTICAL HOLE OR A CRACK Ph.D. Thesis
Michael Kamel 1990 129 p
Avail: Univ. Microfilms Order No. DA9108126

The complex variable method is used to obtain the fundamental solutions for an infinite anisotropic plate with an elliptical hole. The plate is loaded by an arbitrarily positioned point force and/or concentrated moment. Fracture analysis is performed by setting the length of the minor axis of the ellipse equal to zero so that the elliptical hole is reduced into a crack. Using the principle of superposition, any set of general loadings applied anywhere in the domain can be analyzed with the proposed fundamental solutions. A boundary integral equation approach then is developed incorporating the derived fundamental solutions. This approach is used to determine stress intensity factors for cracks in a linearly elastic, anisotropic plate, cracks in anisotropic solid disks, and interaction between a crack and a hole in an anisotropic plate are considered. Numerical results are obtained for various loading conditions in each case and are compared with known solutions where available. The boundary integral equation developed extends only over that portion of the boundary not including the surface of the crack, since the boundary conditions on the crack surface were already incorporated into the fundamental solutions. The fundamental solutions obtained are for a plane, homogeneous, anisotropic body containing a single elliptical hole or a crack. Problems involving more than one hole or crack or more than one material could, in principle, be solved by dividing the region into homogeneous sections, each enclosing only one hole or crack. Author

N91-25193*# California Univ., Santa Barbara. Dept. of Mechanical and Environmental Engineering.
MECHANICAL CHARACTERIZATION AND MODELING OF NON-LINEAR DEFORMATION AND FRACTURE OF A FIBER REINFORCED METAL MATRIX COMPOSITE
S. Jansson Jun. 1991 49 p
(Grant NAG3-894)
(NASA-CR-187131; NAS 1.26:187131) Avail: NTIS HC/MF A03 CSCL 11D

The nonlinear anisotropic mechanical behavior of an aluminum alloy metal matrix composite reinforced with continuous alumina fibers was determined experimentally. The mechanical behavior of the composite were modeled by assuming that the composite has a periodical microstructure. The resulting unit cell problem was solved with the finite element method. Excellent agreement was found between theoretically predicted and measured stress-strain responses for various tensile and shear loadings. The stress-strain responses for transverse and inplane shear were found to be identical and this will provide a simplification of the constitutive equations for the composite. The composite has a very low ductility in transverse tension and a limited ductility in transverse shear that was correlated to high hydrostatic stresses that develop in the matrix. The shape of the initial yield surface was calculated and good agreement was found between the calculated shape and the experimentally determined shape. Author

N91-25194*# Sverdrup Technology, Inc., Brook Park, OH.
CHEMICAL COMPATIBILITY ISSUES RELATED TO USE OF COPPER AS AN INTERFACIAL LAYER FOR SiC FIBER REINFORCED Ti3Al+Nb COMPOSITE Final Report
Ajay K. Misra Jun. 1991 20 p
(Contract NAS3-25266)
(NASA-CR-187100; E-6143; NAS 1.26:187100) Avail: NTIS HC/MF A03 CSCL 11D

The reaction of Cu, a potential interfacial compliant layer for the Ti3Al plus Nb/SiC composite, with SiC, SCS-6 fiber, and the Ti3Al plus Nb matrix was examined at two temperatures: 1223 and 1273 K. Reaction of Cu with SiC resulted in the formation of a CuSi solution and free carbon, the reaction product being molten at 1273 K. Hot pressing the SCS-6 fiber in a Cu matrix at 1273 K resulted in cracking and delamination of the outer carbon-rich coating, thus allowing the Cu to penetrate to the SiC-carbon coating interface and react with SiC. In contrast, no such damage to the outer coating was observed at 1223 K. There was excessive reaction between Cu and the Ti3Al plus Nb matrix, the reaction product being molten both at 1223 and 1273 K. An interlayer of Nb between Cu and Ti3Al plus Nb matrix prevented the reaction between the two. Author

N91-25195*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
TENSILE DEFORMATION DAMAGE IN SiC REINFORCED Ti-15V-3Cr-3Al-3Sn
Bradley A. Lerch and James F. Saltsman Apr. 1991 44 p
(NASA-TM-103620; E-5778; NAS 1.15:103620) Avail: NTIS HC/MF A03 CSCL 11D

The damage mechanisms of a laminated, continuous SiC fiber reinforced Ti-15V-3Cr-3Al-3Sn (Ti-15-3) composite were investigated. Specimens consisting of unidirectional as well as cross-ply laminates were pulled in tension to failure at room temperature and 427 C and subsequently examined metallographically. Selected specimens were interrupted at various strain increments and examined to document the development of damage. When possible, a micromechanical stress analysis was performed to aid in the explanation of the observed damage. The analyses provide average constituent microstresses and laminate stresses and strains. It was found that the damage states were dependent upon the fiber architecture. Author

N91-25196# National Aerospace Lab., Tokyo (Japan).
APPLICATION OF THE BIREFRINGENT-COATING METHOD TO CFRP

Shinichi Koshide Oct. 1990 27 p In JAPANESE; ENGLISH summary
(NAL-TR-1085; ISSN-0389-4010) Avail: NTIS HC/MF A03

The objective is to analyze the stress and strain distributions along the boundary in structural parts of the composites, such as carbon-fiber reinforced plastics (CFRP), by the birefringent-coating method. However, there were some problems in using the method for strain analysis of CFRP, because appearances and mechanical properties of the materials were not suitable for such applications. In this investigation, the problems are solved by introducing the following experimental processes: (1) a process for viewing the isochromatic fringe patterns using the reflected light from the adhesive layer with which aluminum powder was mixed; and (2) a process for analysis of strain components by substituting the relation between the fringe order of the isochromatic fringe patterns and principal strain differences into the Poisson's ratio for an anisotropic material. Author

N91-25197# Oak Ridge National Lab., TN.
TEMPERATURE DEPENDENCE OF THE THERMAL CONDUCTIVITY OF CARBON-CARBON COMPOSITES
R. B. Dinwiddie, J. W. Sapp, and D. A. Bowers (McDonnell-Douglas Missile Systems Co., Saint Louis, MO.) 1991 3 p Presented at the 20th Biennial Conference on Carbon, Santa Barbara, 24-28 Jun. 1991
(Contract DE-AC05-84OR-21400)
(DE91-010133; CONF-910645-1) Avail: NTIS HC/MF A01

High temperature thermal conductivity data of several commercial and developmental 1-D, 2-D, 3-D and 4-D composites are discussed in terms of temperature dependence and composite structure. The samples chosen include a Pseudo-monocrystal graphite and a 2-D composite manufactured by Le Carbone-Lorraine, 1-D and 2-D composites from Mitsubishi Kasei America, Inc., and a 3-D and 4-D composite manufactured by Fiber Materials Incorporated. The Mitsubishi specimens where measured as processed, heat treated by the manufacturer at some undisclosed high temperature and heat treated by ORNL at 3000 C. All specimens were machined into 12.5 mm disks with thicknesses in the range 0.4 to 0.8 cm. DOE

N91-25198*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
MICROFRACTURE IN HIGH TEMPERATURE METAL MATRIX CROSSPLY LAMINATES
Subodh K. Mital and Christos C. Chamis 1991 11 p Presented at the Winter Annual Meeting and Symposium on Failure Mechanisms in High Temperature Composites, Atlanta, GA, 1-6 Dec. 1991; sponsored by AME
(NASA Order C-99066-G)
(NASA-TM-104381; ICOMP-91-8; E-6201; NAS 1.15:104381) Avail: NTIS HC/MF A03 CSCL 11D

Microfracture (fiber/matrix fracture, interphase debonding, and inter-ply delamination) in high temperature metal matrix composites (HTMMC), subjected to both mechanical and thermal loading, is computationally simulated. A crossply 0.3 fiber volume ratio SiC/Ti15 composite with 0/90/0 lay-up is evaluated for microfracture using a multicell finite element model. A computational simulation procedure based on strain energy release rates is used to predict the fracture process and establish the hierarchy of fracture modes. Microfracture results for various loading cases are presented and discussed. Author

N91-25199* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
PROCESS FOR THE MANUFACTURE OF SEAMLESS METAL-CLAD FIBER-REINFORCED ORGANIC MATRIX COMPOSITE STRUCTURES Patent
Raymond M. Bluck, inventor (to NASA), Harold G. Bush, inventor (to NASA), and Robert R. Johnson, inventor (to NASA) (Lockheed Missiles and Space Co., Sunnyvale, CA.) 16 Apr. 1991 6 p Filed 28 Feb. 1990 Division of US-Patent-Appl-SN-921572, filed 21 Oct. 1986
(NASA-Case-LAR-13562-2; US-Patent-5,008,061; US-Patent-Appl-SN-486668; US-Patent-Appl-SN-921572; US-Patent-Class-264-257; US-Patent-Class-264-261; US-Patent-Class-156-625; US-Patent-Class-156-634; US-Patent-Class-156-172; US-Patent-Class-156-187) Avail: US Patent and Trademark Office

A process for producing seamless metal-clad composite structures includes providing a hollow, metallic inner member and an outer sleeve to surround the inner member and define an inner space therebetween. A plurality of continuous reinforcing fibers is attached to the distal end of the outside diameter of the inner member, and the inner member is then introduced, distal end first, into one end of the outer sleeve. The inner member is then moved, distal end first, into the outer sleeve until the inner member is completely enveloped by the outer sleeve. A liquid matrix material is then injected into the space containing the reinforcing fibers between the inner member and the outer sleeve. Next a pressurized heat transfer medium is passed through the inner member to cure the liquid matrix material. Finally, the wall thickness of both the inner member and the outer sleeve are reduced to desired dimensions by chemical etching, which adjusts the thermal expansion coefficient of the metal-clad composite structure to a desired value.
Official Gazette of the U.S. Patent and Trademark Office

N91-25200* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
PREPARING COMPOSITE MATERIALS FROM MATRICES OF PROCESSABLE AROMATIC POLYIMIDE THERMOPLASTIC BLENDS Patent
Norman J. Johnston, inventor (to NASA), Terry L. St.Clair, inventor (to NASA), Robert M. Baucom, inventor (to NASA), and John R. Gleason, inventor (to NASA) 2 Apr. 1991 17 p Filed 21 Oct. 1988 Continuation-in-part of abandoned US-Patent-Appl-SN-105846, filed 8 Oct. 1987
(NASA-Case-LAR-14107-1; US-Patent-5,004,575; US-Patent-Appl-SN-262268; US-Patent-Appl-SN-105846; US-Patent-Class-264-136; US-Patent-Class-264-257; US-Patent-Class-264-331.12; US-Patent-Class-525-432; US-Patent-Class-528-352; US-Patent-Class-528-350) Avail: US Patent and Trademark Office CSCL 11D

Composite materials with matrices of tough, thermoplastic aromatic polyimides are obtained by blending semi-crystalline polyimide powders with polyamic acid solutions to form slurries, which are used in turn to prepare prepregs, the consolidation of which into finished composites is characterized by excellent melt flow during processing.
Official Gazette of the U.S. Patent and Trademark Office

N91-25201*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
HEAT TRANSFER DEVICE Patent Application
Bruce A. Banks, inventor (to NASA) and James R. Gaier, inventor (to NASA) 19 Feb. 1991 10 p
(NASA-Case-LEW-14162-2; NAS 1.71:LEW-14162-2; US-Patent-Appl-SN-657238) Avail: NTIS HC/MF A02 CSCL 11D

Gas derived graphite fibers are generated by the decomposition of an organic gas. These fibers when joined with a suitable binder are used to make a high thermal conductivity composite material. The fibers may be intercalated. The intercalate can be halogen or halide salt, alkaline metal, or any other species which contributes to the electrical conductivity improvement of the graphite fiber. The heat transfer device may also be made of intercalated highly oriented pyrolytic graphite and machined, rather than made of fibers. NASA

N91-25202*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
METHOD OF APPLYING A THERMAL BARRIER COATING SYSTEM TO A SUBSTRATE Patent Application
Robert A. Miller, inventor (to NASA) 23 May 1991 10 p
(NASA-Case-LEW-15020-2; NAS 1.71:LEW-15020-2;

US-Patent-Appl-SN-708255) Avail: NTIS HC/MF A02 CSCL 11D

A metallic close-out layer is applied to the surface of a thermal barrier coating system to seal the ceramic material in the coating. The close-out layer is glass-bead preened to densify the surface. NASA

25 INORGANIC AND PHYSICAL CHEMISTRY

Includes chemical analysis, e.g., chromatography; combustion theory; electrochemistry; and photochemistry.

For related information see also *77 Thermodynamics and Statistical Physics.*.

N91-25203*# Arizona Univ., Tucson. NASA Space Engineering Research Center.

NASA SPACE ENGINEERING RESEARCH CENTER FOR UTILIZATION OF LOCAL PLANETARY RESOURCES Annual Progress Report, 1988-1989

Kumar Ramohalli and John S. Lewis 1989 173 p (NASA-CR-188221; NAS 1.26:188221) Avail: NTIS HC/MF A08 CSCL 07D

Progress toward the goal of exploiting extraterrestrial resources for space missions is documented. Some areas of research included are as follows: Propellant and propulsion optimization; Automation of propellant processing with quantitative simulation; Ore reduction through chlorination and free radical production; Characterization of lunar ilmenite and its simulants; Carbothermal reduction of ilmenite with special reference to microgravity chemical reactor design; Gaseous carbonyl extraction and purification of ferrous metals; Overall energy management; and Information management for space processing. For individual titles, see N91-25204 through N91-25222.

N91-25204*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.

PROOF-OF-CONCEPT AUTOMATION OF PROPELLANT PROCESSING **c28**

Kumar Ramohalli and P. A. Schallhorn *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 10 p (For primary document see N91-25203 17-25)

Avail: NTIS HC/MF A08 CSCL 22I

For space-based propellant production, automation of the process is needed. Currently, all phases of terrestrial production have some form of human interaction. A mixer was acquired to help perform the tasks of automation. A heating system to be used with the mixer was designed, built, and installed. Tests performed on the heating system verify design criteria. An IBM PS/2 personal computer was acquired for the future automation work. It is hoped that some the mixing process itself will be automated. This is a concept demonstration task; proving that propellant production can be automated reliably. Author

N91-25205*# Arizona Univ., Tucson. Lunar and Planetary Lab.

EXTRACTION OF VOLATILES AND METALS FROM EXTRATERRESTRIAL ORES **c91**

John S. Lewis *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 2 p (For primary document see N91-25203 17-25)

Avail: NTIS HC/MF A08 CSCL 03B

Extraterrestrial materials, processes, and products were identified which are associated with the production of propellants in space, including the most complete possible conversion of the feedstocks for propellant production into useful products with the minimum feasible expenditure of energy. Laboratory research was identified and begun on several processes that promise very large increases in the mass of useful products at the cost of only modest increases in energy consumption. Processes for manufacturing propellants then become processes for making propellants plus metals and refractories. It is the overall yield of useful materials per unit expended energy that matters, not simply the yield of propellants. Three tasks have been undertaken to date: (1) Literature search and compilation of a dBase 3 data base on space materials processing; (2) Gaseous carbonyl extraction and purification of ferrous metals; and (3) Characterization of lunar ilmenite and its simulants. Author

N91-25206*# Arizona Univ., Tucson. Dept. of Chemical Engineering.

PRODUCTION OF OXYGEN FROM LUNAR ILMENITE

F. Shadman and Y. Zhao *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 15 p (For primary document see N91-25203 17-25)

Avail: NTIS HC/MF A08 CSCL 07D

The overall objective of this project was to develop a novel carbothermal reduction process for production of oxygen from lunar ilmenite. The specific objective was to use a reaction sequence in which a wide variety of carbonaceous compounds (including carbonaceous wastes) can be used as reducing agents. During the first phase, two reactor systems were designed, constructed, and operated to study the reaction fundamental important in this process. One system is a small fluidized bed, and the other is a thermo-gravimetric reactor system. Preliminary experiments on synthetic ilmenite are conducted to study the effect of carbon type, carbon loading, temperature, and gas flow rate. Results indicate that a reaction path based on carbon gasification can be used to promote the overall kinetics. A unique temperature and concentration-programmed reaction procedure was being developed for rapid parametric study of the process. Author

N91-25207*# Arizona Univ., Tucson. Dept. of Materials Science and Engineering.

CHLORINATION PROCESSING OF LOCAL PLANETARY ORES FOR OXYGEN AND METALLURGICALLY IMPORTANT METALS **c26**

D. C. Lynch *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 11 p (For primary document see N91-25203 17-25)

Avail: NTIS HC/MF A08 CSCL 11F

The use of chlorine to extract, reclaim, and purify metals has attractive possibilities for extraterrestrial processing of local planetary resources. While a complete cyclic process has been proposed for the recovery of metallurgically significant metals and oxygen, herein the chlorination step of the cycle is examined. An experimental apparatus for reacting refractory materials, such as ilmenite, in a microwave induced plasma is being built. Complex equilibria calculations reveal that stable refractory materials can, under the influence of a plasma, undergo chlorination and yield oxygen as a by-product. These issues and the potential advantages for plasma processing in space are reviewed. Also presented is a discussion of the complex equilibria program used in the analysis. Author

N91-25208*# Washington Univ., Saint Louis, MO. Dept. of Earth and Planetary Sciences.

OXYGEN AND IRON PRODUCTION BY ELECTROLYTIC SMELTING OF LUNAR SOIL

Larry A. Haskin *In* Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 6 p (For primary document see N91-25203 17-25)

Avail: NTIS HC/MF A08 CSCL 07D

Previous work has shown that Fe(sup 0) and O2 can be derived by electrolysis from silicate smelt of a composition typical of lunar soils (Lindstrom and Haskin 1979). In the present study, the goal is to refine further the conditions necessary to optimize production and to determine efficiencies of production (how much product is derived for a given current) and purity of products. These depend on several factors, including potential imposed between electrodes, configuration and surface area of the electrodes, composition of the electrolyzed silicate melt, and oxygen fugacity. Experiments were designed to measure the dependence on these variables of three parameters that must be known before production by

electrolysis can be optimized. These parameters are: Limiting Current; Actual Current; and Efficiencies of Production. Author

N91-25209*# Tennessee Univ., Knoxville. Dept. of Materials Science and Engineering.
AN INVESTIGATION OF SOME MECHANICAL AND THERMAL PROPERTIES OF LUNAR SIMULANT MATERIALS HEATED AT 2.45 GHz
T. T. Meek *In* Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 5 p (For primary document see N91-25203 17-25)
Avail: NTIS HC/MF A08 CSCL 07D

Lunar simulant material was fabricated to simulate Apollo 11, Apollo 15, and Apollo 16 soils. The approximate compositions which these soils simulate are given. Samples of each soil simulate were fabricated into right circular cylinders, placed into a microwave reaction cavity, and heated using 2.45 GHz radiation to a particular processing temperature at which it was held for a prescribed length of time. Examples are given of two microwave heating programs for these simulant samples. Upon completion of thermal processing, each sample had its top and bottom surfaces polished. A technique was employed which looks at hardness data to determine the fracture toughness of a material and then relates this to thermal shock resistance. Some advantages of this technique are its low cost for analysis and thermal shock resistance as a function of initial sample orientation in the microwave field can be determined. Samples were prepared for testing and results are expected. At the same time, other samples are currently being investigated using scanning electron microscopy to determine their microstructures. Author

N91-25210*# Arizona Univ., Tucson. Dept. of Geosciences.
ABUNDANCES OF VOLATILE-BEARING PHASES IN CARBONACEOUS CHONDRITES AND COOLING RATES OF METEORITES BASED ON CATION ORDERING OF ORTHOPYROXENES **c90**
Jibamitra Ganguly *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 5 p (For primary document see N91-25203 17-25)
Avail: NTIS HC/MF A08 CSCL 03B

Results of preliminary calculations of volatile abundances in carbonaceous chondrites are discussed. The method (Ganguly 1982) was refined for the calculation of cooling rate on the basis of cation ordering in orthopyroxenes, and it was applied to the derivation of cooling rates of some stony meteorites. Evaluation of cooling rate is important to the analysis of condensation, accretion, and post-accretionary metamorphic histories of meteorites. The method of orthopyroxene speedometry is widely applicable to meteorites and would be very useful in the understanding of the evolutionary histories of carbonaceous chondrites, especially since the conventional metallographic and fission track methods yield widely different results in many cases. Abstracts are given which summarize the major conclusions of the volatile abundance and cooling rate calculations. Author

N91-25211*# Arizona Univ., Tucson. Dept. of Geosciences.
BENEFICIATION OF LUNAR ILMENITE FEEDSTOCK Abstract Only
J. Ruiz *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 1 p (For primary document see N91-25203 17-25)
Avail: NTIS HC/MF A08 CSCL 07D

The chemical and physical characteristics are reviewed of ilmenite in lunar material and high precision, low abundance analyses were developed for platinoids and other possibly important elements in space materials using an induced coupled plasma mass spectrometer. Author

N91-25212*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
UNCONVENTIONAL PROPELLANT PERFORMANCE Abstract Only **c28**
Kumar Ramohalli and Mario Rascon *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 2 p (For primary document see N91-25203 17-25)
Avail: NTIS HC/MF A08 CSCL 21I

Theoretical calculations are made of rocket performance of exotic fuels at various operating conditions such as chamber pressure, pressure ratios, and oxidizer-to-fuel ratios. By exotic fuels, it is meant using materials that may not normally be used as fuels here on Earth due to low performance. The majority of the work is currently being done on a VAX using the CET 86 program by Gordon and McBride. The CET 86 program will be installed on our IBM PS/2 Model 80 to reduce computer costs. The JPL Solid Propellant Theoretical Performance program for the IBM was also used, it handles solid fuels better than the CET 86 program. The CET 86 program by Gordon and McBride was set on the VAX and results were obtained for a number of the propellant combinations being analyzed. A sample of these results is included. Several programs were written to reduce the large amounts of data generated to include only the information needed, such as specific impulse, temperature, etc. This work involves analyzing propellants at various operating conditions and determining which will give acceptable performance and yet be easily storable for long periods of time and be readily available in space missions. Author

N91-25213*# Arizona Univ., Tucson. Dept. of Civil Engineering and Engineering Mechanics.
DEVELOPMENT OF CONSTRUCTION MATERIALS LIKE CONCRETE FROM LUNAR SOILS WITHOUT WATER **c91**
Chandra S. Desai, H. Saadatmanesh, and G. Frantziskonis *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 3 p (For primary document see N91-25203 17-25)
Avail: NTIS HC/MF A08 CSCL 03B

The development of construction materials such as concrete from lunar soils without the use of water requires a different methodology than that used for conventional terrestrial concrete. A unique approach is attempted that utilizes factors such as initial vacuum and then cyclic loading to enhance the mechanical properties of dry materials similar to those available on the moon. The application of such factors is expected to allow reorientation, and coming together, of particles of the materials toward the maximum theoretical density. If such a density can provide deformation and strength properties for even a limited type of construction, the approach can have significant application potential, although other factors such as heat and chemicals may be needed for specific construction objectives. Author

N91-25214*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
INTERDEPENDENT FIGURE-OF-MERIT SOFTWARE DEVELOPMENT **c61**
K. Ramohalli and T. Kirsch *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 4 p (For primary document see N91-25203 17-25)
Avail: NTIS HC/MF A08 CSCL 09B

This program was undertaken in order to understand the complex nature of interdependent performance in space missions. At the first step in a planned sequence of progress, a spread sheet program was developed to evaluate different fuel/oxidizer combinations for a specific Martian mission. This program is to be linked with output attained using sophisticated software produced by Gordon and McBride. The programming to date makes use of 11 independent parameters. Optimization is essential when faced with the incredible magnitude of costs, risks, and benefits involved with space exploration. A system of weights needs to be devised on which to measure the options. It was the goal to devise a Figure of Merit (FoM) on which different choices can be presented and made. The plan was to model typical missions to Mars, identify the parameters, and vary them until the best one is found. Initially, most of the focus was placed on propellant selection. Author

N91-25215*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
QUANTITATIVE COMPUTER SIMULATIONS OF EXTRATERRESTRIAL PROCESSING OPERATIONS **c28**
T. L. Vincent and P. E. Nikravesh *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 3 p (For primary document see N91-25203 17-25)
Avail: NTIS HC/MF A08 CSCL 21I

The automation of a small, solid propellant mixer was studied. Temperature control is under investigation. A numerical simulation of the system is under development and will be tested using different control options. Control system hardware is currently being put into place. The construction of mathematical models and simulation techniques for understanding various engineering processes is also studied. Computer graphics packages were utilized for better visualization of the simulation results. The mechanical mixing of propellants is examined. Simulation of the mixing process is being done to study how one can control for chaotic behavior to meet specified mixing requirements. An experimental mixing chamber is also being built. It will allow visual tracking of particles under mixing. The experimental unit will be used to test ideas from chaos theory, as well as to verify simulation results. This project has applications to extraterrestrial propellant quality and reliability. Author

N91-25216*# Arizona Univ., Tucson. Dept. of Nuclear and Energy Engineering.
ENERGY MANAGEMENT STUDY FOR LUNAR OXYGEN PRODUCTION
R. A. Fazzolare and B. G. Wong-Swanson *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 4 p (For primary document see N91-25203 17-25)
Avail: NTIS HC/MF A08 CSCL 07D

Energy management opportunities in the process of hydrogen reduction of ilmenite for lunar oxygen production are being investigated. An optimal energy system to supply the power requirements for the process will be determined. Author

N91-25217*# Planetary Science Inst., Tucson, AZ.
DEVELOPMENT OF THE DATA BASE FOR NEAR-EARTH RESOURCES Abstract Only **c82**
D. R. Davis *In* Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 1 p (For primary document see N91-25203 17-25)
Avail: NTIS HC/MF A08 CSCL 05B

Development of the data base for near-Earth resources was begun. Specific items accomplished were: (1) Definition of data base contents via discussions among the PSI staff and outside scientist such as Lucy McFadden and Mark Skyes; (2) Discussion/demonstration of dBase capabilities and possible organization of file(s) with L. Alvarez, Steward Observatory; (3) Data base entries for near-Earth asteroids consisting of data from the Russian ephemeris, a forthcoming review chapter for the Asteroids 2 book, and other literature; and (4) Development of a list of asteroid observers worldwide to be contacted during the coordinated phase of the project. A copy of the data base as it now exists is included. Author

N91-25218*# California Univ., San Diego. Space Inst.
BIBLIOGRAPHIC SEARCH OF THE LITERATURE ON LUNAR PROCESSING Abstract Only **c82**
D. R. Criswell *In* Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 1 p (For primary document see N91-25203 17-25)
Avail: NTIS HC/MF A08 CSCL 05B

The Lunar and Planetary Institute (LPI) search produced approximately 80 references. Most of these are available at the LPI. The product includes only the author, title, date, and reference. The earliest (Cooper et al., Certain ecological aspects of a closed lunar base, Rand Corp.) is dated 6 March 1958. The latest is a semi-popular article (Cole and Majdacic, Astronomy, vol. 16) produced last year. The early references tend to be reports of government sponsored engineering studies. The later are generally semi-popular and science press articles. These references will be obtained on disk from the LPI and can be converted into an ASCII file for access via IBM-compatible PCs. Author

N91-25219*# Arizona Univ., Tucson.
AN ANNOTATED BIBLIOGRAPHY OF PROPELLANT PROCESSING METHODS **c28**
A. H. Cutler *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 5 p (For primary document see N91-25203 17-25)
Avail: NTIS HC/MF A08 CSCL 21I

The author has specialized in space resources research for many years, with special emphasis on oxygen reduction methods. He has been retained to write a comprehensive review of these methods, detailing advantages and disadvantages, listing by-products and presenting recommendations. As the first step, an extensive outline was prepared, and the portion of this outline covering product manufacture was selected as the initial goal. A working version is presented. Author

N91-25220*# Planetary Science Inst., Tucson, AZ.
PRELIMINARY ANALYSIS OF SURFACE CHARACTERISTICS OF COMET TEMPEL 2 Abstract Only **c90**
H. Campins *In* Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 1 p (For primary document see N91-25203 17-25)
Avail: NTIS HC/MF A08 CSCL 03B

A preliminary analysis of the surface characteristics of Comet Tempel 2 was completed and incorporated into the paper The Nucleus of Comet Tempel 2 by M. F. A'Hearn, H. Campins, D. G. Schleicher, and R. L. Millis which was submitted to the Astrophysical Journal, March 1989. A detailed analysis of the surface characteristics of Comet Arend-Rigaux and Comet Tempel 2 is being carried out in collaboration with Dr. R. H. Brown (JPL).
Author

N91-25221*# Arizona Univ., Tucson. Lunar and Planetary Lab.
NOTES ON LUNAR ILMENITE **c90**
M. L. Hutson *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 6 p (For primary document see N91-25203 17-25)
Avail: NTIS HC/MF A08 CSCL 03B

Opaques (mostly ilmenite) make up 0 to 5 percent of highland rocks, 1 to 11 percent of low-Ti mare basalts, and 10 to 34 percent of high-Ti mare basalts (Carter 1988). Apollos 11 and 17 sampled high-Ti basalts. Apollos 12 and 14 sampled low-Ti basalts. Apollo 15 sampled a complex mixture of mare and highland material. Apollo 16 sampled mainly highland material (Taylor 1975). Author

N91-25222*# Arizona Univ., Tucson. Dept. of Geosciences.
THEORETICAL PREDICTIONS OF VOLATILE BEARING PHASES AND VOLATILE RESOURCES IN SOME CARBONACEOUS CHONDRITES **c90**
Jibamitra Ganguly and Surendra K. Saxena (City Univ. of New York, Brooklyn.) *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 9 p (For primary document see N91-25203 17-25)
Avail: NTIS HC/MF A08 CSCL 03B

Carbonaceous chondrites are usually believed to be the primary constituents of near-Earth asteroids and Phobos and Diemos, and are potential resources of fuels which may be exploited for future planetary missions. The nature and abundances are calculated of the major volatile bearing and other phases, including the vapor phase that should form in C1 and C2 type carbonaceous chondrites as functions of pressure and temperature. The results suggest that talc, antigorite plus or minus magnesite are the major volatile bearing phases and are stable below 400 C at 1 bar in these chondritic compositions. Simulated heating of a kilogram of C2 chondrite at fixed bulk composition between 400 and 800 C at 1 bar yields about 135 gm of volatile, which is made primarily of H2O, H2, CH4, CO2 and CO. The relative abundances of these

volatile species change as functions of temperature, and on a molar basis, H2 becomes the most dominant species above 500 C. In contrast, CI chondrites yield about 306 gm of volatile under the same condition, which consist almost completely of 60 wt percent H2O and 40 wt percent CO2. Preliminary kinetic considerations suggest that equilibrium dehydration of hydrous phyllosilicates should be attainable within a few hours at 600 C. These results provide the framework for further analyses of the volatile and economic resource potentials of carbonaceous chondrites. Author

N91-25223*# Arizona Univ., Tucson. NASA Space Engineering Research Center.
NASA SPACE ENGINEERING RESEARCH CENTER FOR UTILIZATION OF LOCAL PLANETARY RESOURCES Annual Progress Report, 1989-1990
Kumar Ramohalli and John S. Lewis 1990 285 p Original contains color illustrations
(NASA-CR-188220; NAS 1.26:188220) Avail: NTIS HC/MF A13; 5 functional color pages CSCL 07D

The University of Arizona and NASA have joined to form the UA/NASA Space Engineering Research Center. The purpose of the Center is to discover, characterize, extract, process, and fabricate useful products from the extraterrestrial resources available in the inner solar system (the moon, Mars, and nearby asteroids). Individual progress reports covering the center's research projects are presented and emphasis is placed on the following topics: propellant production, oxygen production, ilmenite, lunar resources, asteroid resources, Mars resources, space-based materials processing, extraterrestrial construction materials processing, resource discovery and characterization, mission planning, and resource utilization. For individual titles, see N91-25224 through N91-25249.

N91-25224*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
PERFORMANCE OF UNCONVENTIONAL PROPELLANTS c28
Mario Rascon *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 3 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 21I

This research involves the theoretical calculations of rocket performance for exotic propellants at various operating conditions, such as chamber pressure, pressure ratios, and oxidizer-to-fuel ratios. Exotic propellants are materials that may not normally be used as propellants on earth due to their low performance characteristics or other factors. The majority of the work was done using the Gordon and McBride CET 86 Program in both a mainframe version and personal computer versions. In addition, the Lockheed/Air Force Solid Propellant Theoretical Performance Program for the IBM PS/2, which handles condensed product species better, was also used. Author

N91-25225*# Arizona Univ., Tucson. Dept. of Materials Science and Engineering.
COLD PLASMA PROCESSING OF LOCAL PLANETARY ORES FOR OXYGEN AND METALLURGICALLY IMPORTANT METALS c75
D. C. Lynch, D. Bullard, and R. Ortega *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 5 p Original contains color illustrations (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 20I

The utilization of a cold plasma in chlorination processing is described. Essential equipment and instruments were received, the experimental apparatus assembled and tested, and preliminary experiments conducted. The results of the latter lend support to the original hypothesis: a cold plasma can both significantly enhance and bias chemical reactions. In two separate experiments, a cold plasma was used to reduce TiCl4 vapor and chlorinate ilmenite. The latter, reacted in an argon-chlorine plasma, yielded oxygen. The former experiment reveals that chlorine can be recovered as HCl vapor from metal chlorides in a hydrogen plasma. Furthermore, the success of the hydrogen experiments has lead to an analysis of the feasibility of direct hydrogen reduction of metal oxides in a cold plasma. That process would produce water vapor and numerous metal by-products. Author

N91-25226*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
AUTONOMOUS PRODUCTION OF PROPELLANTS c28
Kumar Ramohalli and P. A. Schallhorn *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 3 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 21I

The autonomous production of propellants is addressed. Since 80 to 90 percent of a spacecraft's mass is typically propellants, it is advantageous to produce propellants in strategic locations en route to, and at, the desired mission destination. This reduces the weight of the spacecraft and the cost of each mission. Since one of the primary goals of the space program is safety, a totally automated propellant production system is desirable. This system would remove, from hostile, high-risk extraterrestrial environments, the constant human intervention currently required in the production of many propellants. This enables the exploration of space to be more than the search for and production of fuel. As a proof-of-concept demonstration, one specific case was chosen for this study. That case was a composite propellant processor (the principle is more important than the application), and the specific processor used saved SERC the considerable cost of acquiring a new liquid propellant processor that would also have required similar automation. Author

N91-25227*# Arizona Univ., Tucson. Lunar and Planetary Lab.
EXTRACTION OF VOLATILE AND METALS FROM EXTRATERRESTRIAL MATERIALS c26
John S. Lewis *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 7 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 11F

Since March 1, 1989, attention was concentrated on the extraction of ilmenite from extraterrestrial materials and on the planning and development of laboratory facilities for carbonyl extraction of ferrous metal alloys. Work under three subcontracts was administered by this project: (1) electrolytic production of oxygen from molten lunar materials; (2) microwave processing of lunar materials; and (3) production of a resource-oriented space science data base. Author

N91-25228*# Arizona Univ., Tucson. Dept. of Geosciences.
ILMENITE BENEFICIATION AND HIGH-PRECISION ANALYSES OF EXTRATERRESTRIAL MATERIAL Abstract Only
J. Ruiz *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 2 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 07D

During the past year, work on characterizing lunar material that has the potential of becoming ilmenite lunar ore was performed. The important aspects of any such material are that it has abundant ilmenite and that the ilmenite be easily separated. The final result sought is a pure (greater than 99 percent ilmenite) concentrate that will be used as feed for the ilmenite reduction process. There are two types of starting material available on the moon. Solid rock (basalt or anorthosite) and regolith. Extensive literature reviews of ilmenite separation experiments were performed, and simulants (meteorites) were separated. It was concluded that, because of the large amounts of agglomerates, regolith may not be the best starting material for ilmenite beneficiation and that either basalts or anorthosites may be better. This is because no matter how finely the regolith is ground, it would not be possible to efficiently separate all the ilmenite. This hypotheses, however, needs to be tested with lunar material. Author

N91-25229*# Arizona Univ., Tucson. Dept. of Chemical Engineering.
PRODUCTION OF OXYGEN FROM LUNAR ILMENITE
Y. Zhao and F. Shadman *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 5 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 07D

The following subjects are addressed: (1) the mechanism and kinetics of carbothermal reduction of simulated lunar ilmenite using carbon and, particularly, CO as reducing agents; (2) the determination of the rate-limiting steps; (3) the investigation of the effect of impurities, particularly magnesium; (4) the search for catalysts suitable for enhancement of the rate-limiting step; (5) the comparison of the kinetics of carbothermal reduction with those of hydrogen reduction; (6) the study of the combined use of CO and hydrogen as products of gasification of carbonaceous solids; (7) the development of reduction methods based on the use of waste carbonaceous compounds for the process; (8) the development of a carbothermal reaction path that utilizes gasification of carbonaceous solids to reducing gaseous species (hydrocarbons and carbon monoxide) to facilitate the reduction reaction kinetics and make the process more flexible in using various forms of carbonaceous feeds; (9) the development of advanced gas separation techniques, including the use of high-temperature ceramic membranes; (10) the development of an optimum process flow sheet for carbothermal reduction, and comparison of this process with the hydrogen reduction scheme, as well as a general comparison with other leading oxygen production schemes; and (11) the use of new and advanced material processing and separation techniques. Author

N91-25230*# Arizona Univ., Tucson. Dept. of Geosciences.
VOLATILE-BEARING PHASES IN CARBONACEOUS CHONDRITES: COMPOSITIONS, MODAL ABUNDANCE, AND REACTION KINETICS
Jibamitra Ganguly *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 4 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 07D

The spectral and density characteristics of Phobos and Deimos (the two small natural satellites of Mars) strongly suggest that a significant fraction of the near-earth asteroids are made of carbonaceous chondrites, which are rich in volatile components and, thus, could serve as potential resources for propellants and life supporting systems in future planetary missions. However, in order to develop energy efficient engineering designs for the extraction of volatiles, knowledge of the nature and modal abundance of the minerals in which the volatiles are structurally bound and appropriate kinetic data on the rates of the devolatilization reactions is required. Theoretical calculations to predict the modal abundances and compositions of the major volatile-bearing and other mineral phases that could develop in the bulk compositions of C1 and C2 classes (the most volatile rich classes among the carbonaceous chondrites) were performed as functions of pressure and temperature. The rates of dehydration of talc at 585, 600, 637, and 670 C at P(total) = 1 bar were determine for the reaction: Talc = 3 enstatite + quartz + water. A scanning electron microscopic study was conducted to see if the relative abundance of phases can be determined on the basis of the spectral identification and x ray mapping. The results of this study and the other studies within the project are discussed.
Author

N91-25231*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
QUANTITATIVE COMPUTER REPRESENTATION OF PROPELLANT PROCESSING **c28**
M. D. Hicks and P. E. Nikravesh *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 7 p Original contains color illustrations (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 21I

With the technology currently available for the manufacture of propellants, it is possible to control the variance of the total specific impulse obtained from the rocket boosters to within approximately five percent. Though at first inspection this may appear to be a reasonable amount of control, when it is considered that any uncertainty in the total kinetic energy delivered to the spacecraft translates into a design with less total usable payload, even this degree of uncertainty becomes unacceptable. There is strong motivation to control the variance in the specific impulse of the shuttle's solid boosters. Any small gains in the predictability and reliability of the booster would lead to a very substantial payoff in earth-to-orbit payload. The purpose of this study is to examine one aspect of the manufacture of solid propellants, namely, the mixing process. The traditional approach of computational fluid mechanics is notoriously complex and time consuming. Certain simplifications are made, yet certain fundamental aspects of the mixing process are investigated as a whole. It is possible to consider a mixing process in a mathematical sense as an operator, F, which maps a domain back upon itself. An operator which demonstrates good mixing should be able to spread any subset of the domain completely and evenly throughout the whole domain by successive applications of the mixing operator, F. Two and three dimensional models are developed and graphical visualization two and three dimensional mixing processes are presented.
Author

N91-25232*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
TEMPERATURE AUTOMATION FOR A PROPELLANT MIXER **c28**
T. L. Vincent and R. G. Wilson *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 4 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 21I

The analysis and installation of an automatic temperature controller on a propellant mixer is presented. Ultimately, the entire mixing process will come under automation, but since precise adherence to the temperature profile is very difficult to sustain manually, this was the first component to be automated. Automation is not only important for producing a uniform product, but it is necessary for envisioned space-based propellant production.
Author

N91-25233*# Arizona Univ., Tucson. Dept. of Materials Science and Engineering.
INNOVATIVE TECHNIQUES FOR THE PRODUCTION OF ENERGETIC RADICALS FOR LUNAR MATERIALS PROCESSING INCLUDING PHOTOGENERATION VIA CONCENTRATED SOLAR ENERGY
D. E. Osborn, D. C. Lynch, and R. Fazzolari *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 7 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 21I

The Department of Materials Science and Engineering (MSE) is investigating the use of monatomic chlorine produced in a cold plasma to recover oxygen and metallurgically significant metals from lunar materials. Development of techniques for the production of the chlorine radical (and other energetic radicals for these processes) using local planetary resources is a key step for a successful approach. It was demonstrated terrestrially that the use of UV light to energize the photogeneration of OH radicals from ozone or hydrogen peroxide in aqueous solutions can lead to rapid reaction rates for the breakdown of toxic organic compounds in water. A key question is how to use the expanded solar resource at the lunar surface to generate process-useful radicals. This project is aimed at investigating that question.
Author

N91-25234*# Washington Univ., Seattle. Dept. of Earth and Planetary Sciences.
OXYGEN PRODUCTION BY ELECTROLYSIS OF MOLTEN LUNAR REGOLITH
Larry A. Haskin *In* Arizona Univ., NASA Space Engineering

Research Center for Utilization of Local Planetary Resources 1990 10 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 07D

The goal of this study was threefold. First, the theoretical energy requirements of the process were to be defined. This includes studies of the relevant oxidation-reduction reactions in the melt, their kinetics and energies of reaction, and experimental determination of production efficiencies and melt resistivities as functions of melt composition and applied potential. Second, the product(s) of silicate electrolysis were to be characterized. This includes: (1) evaluating the phase relationships in the systems SiO2-TiO2-Al2O3-MgO-FeO-CaO and Fe-Si; (2) estimating the compositions of the metal products as a function of applied potential and feedstock composition based on phase equilibria in the Fe-Si system and free energy values for SiO2 and FeO reported in the literature; (3) definition of compositions of products in actual experiments; and (4) definition of the form the product takes (whether phases separate or remain fixed, whether crystals settle or float in the remaining melt, and how large crystals form). Third, materials for these highly corrosive high-temperature silicate melts were to be identified. This includes identifing materials that may be either inert or thermodynamically stable in these melts, and experimental testing of the materials to confirm that they do not deteriorate. The results are discussed within this framework. Author

N91-25235*# Arizona Univ., Tucson. Lunar and Planetary Lab.
HELIUM-3 IN THE LUNAR REGOLITH Abstract Only c91
T. Swindle *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 2 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 03B

A preliminary assessment of He-3 distribution in lunar soils was completed, including variations with soil location, depth, composition, grain size, and other parameters that might be useful in developing mining scenarios. One of the primary tools was a compilation of available analyses of He-3 in lunar samples. The compilation includes analyses of more than 250 numbered samples (plus duplicates and subsamples in many cases) from the American and Russian lunar programs, reported in nearly 100 publications. In addition, average abundances for soils from each of the Apollo landing sites were computed. These were coupled with models and measurements of other pertinent parameters. Author

N91-25236*# Science Applications International Corp., San Diego, CA.
THE FEASIBILITY OF SOLAR REFLECTOR PRODUCTION FROM LUNAR MATERIALS FOR SOLAR POWER IN SPACE c44
In Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 15 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 10A

Science Applications International Corporation (SAIC) investigated the feasibility of producing solar reflectors from indigenous lunar materials for solar power production on the moon. First, lunar construction materials and production processes were reviewed, and candidate materials for reflector production were identified. At the same time, lunar environmental conditions were reviewed for their effect on production of concentrators. Next, conceptual designs and fabrication methods were proposed and studied for production of dish concentrators and heliostats. Finally, fabrication testing was performed on small-scale models using earth analogs of lunar materials. Findings from this initial investigation indicate that production of concentrators from lunar materials may be an attractive approach for solar energy production on the moon. Further design and testing are required to determine the best techniques and approaches to optimize this concept. Four materials were identified as having high potential for solar reflector manufacture. These baseline materials were foamed glass, concrete with glass-fiber reinforcement, a glass-fiber/glass-melt composite, and an iron-glass sintered material. Author

N91-25237*# Tennessee Univ., Knoxville. Dept. of Materials Science and Engineering.
INVESTIGATION OF MECHANICAL AND THERMAL PROPERTIES OF MICROWAVE-SINTERED LUNAR SIMULANT MATERIALS USING 2.45 GHz RADIATION
T. T. Meek *In* Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 8 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 07D

The mechanical and thermal properties of lunar simulant material were investigated. An alternative method of examining thermal shock in microwave-sintered lunar samples was researched. A computer code was developed that models how the fracture toughness of a thermally shocked lunar simulant sample is related to the sample hardness as measured by a micro-hardness indentor apparatus. This technique enables much data to be gathered from a few samples. Several samples were sintered at different temperatures and for different times at the temperatures. The melting and recrystallization characteristics of a well-studied binary system were also investigated to see if the thermodynamic barrier for the nucleation of a crystalline phase may be affected by the presence of a microwave field. The system chosen was the albite (sodium alumino silicate) anorthite system (calcium alumino silicate). The results of these investigations are presented. Author

N91-25238*# Arizona Univ., Tucson. Dept. of Civil Engineering and Engineering Mechanics.
DEVELOPMENT AND MECHANICAL PROPERTIES OF CONSTRUCTION MATERIALS FROM LUNAR SIMULANTS c31
Chandra S. Desai *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 4 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 13B

The development of construction materials such as concrete from lunar soils without the use of water requires a different methodology than that used for conventional terrestrial concrete. Currently, this research involves two aspects: (1) liquefaction of lunar simulants with various additives in a furnace so as to produce a construction material like an intermediate ceramic; and (2) cyclic loading of simulant with different initial vacuums and densities with respect to the theoretical maximum densities (TMD). In both cases, bending, triaxial compression, extension, and hydrostatic tests will be performed to define the stress-strain strength response of the resulting materials. In the case of the intermediate ceramic, bending and available multiaxial test devices will be used, while for the compacted case, tests will be performed directly in the new device. The tests will be performed by simulating in situ confining conditions. A preliminary review of high-purity metal is also conducted. Author

N91-25239*# Arizona Univ., Tucson. Dept. of Chemistry and Strategic Metals Recovery Research Facility.
RECOVERY OF PRECIOUS METALS IN SPACE Abstract Only c26
H. Freiser *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 1 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 11F

This program is proceeding along the lines compatible with the objective of developing feasible separation and recovery processes for precious metals in a space environment. Efficient, compact, solvent extraction systems (both single and multistage) capable of high selectivity and rapid equilibration that are based on chelate and ion pair complexes are being explored. Two research projects were undertaken: (1) study of the time-dependent aspects of the formation of Pd(2) extractable chelate complexes; and (2) development of a multistage countercurrent distribution process for the separation and recovery of Pd(2) and Pt(2) ions. Author

N91-25240*# Arizona Univ., Tucson. Lunar and Planetary Lab.
SEARCH FOR NEAR-EARTH ASTEROIDS WITH THE SPACEWATCH CAMERA **c90**
T. Gehrels *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 2 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 03B

The Spacewatch Program began as an engineering development of the discovery of near-earth asteroids and comets, with the firs observations starting in 1983, using an RCA charge coupled device (CCD) that has 320 x 512 pixels. Extensive software was written to scan the sky and learn how to do astrometry for precise orbits of newly discovered objects. The merit of the concept was proven, with many observations reported and comets recovered. The precision of astrometric observations for comets and asteroids was improved. For efficient scanning and discovery of new objects, a Tektronix 2048 x 2048 CCD was obtained and is now permanently on the Spacewatch Telescope. Other aspects of the Spacewatch Program are briefly discussed. Author

N91-25241*# Arizona Univ., Tucson. Dept. of Geosciences.
DETERMINATION OF LUNAR ILMENTITE ABUNDANCES FROM REMOTELY SENSED DATA **c91**
J. R. Johnson, S. M. Larson, and Robert B. Singer *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 13 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 03B

The mapping of ilmenite on the surface of the moon is a necessary precursor to the investigation of prospective lunar base sites. Telescopic observations of the moon using a variety of narrow bandpass optical interference filters are being performed as a preliminary means of achieving this goal. Specifically, ratios of images obtained using filters centered at 0.40 and 0.56 microns provide quantitative estimates of TiO2 abundances. Analysis of preliminary distribution maps of TiO2 concentrations allows identification of specific high-Ti areas. Investigations of these areas using slit spectra in the range 0.03 to 0.85 microns are underway to search for discrete spectral signatures attributable to ilmenite. Author

N91-25242*# Arizona Univ., Tucson. Lunar and Planetary Lab.
COMPOSITIONS OF NEAR-EARTH ASTEROIDS **c90**
Larry A. Lebofsky and Marcia L. Nelson *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 4 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 03B

Observational studies of near-earth asteroids and development of techniques for determining their composition were continued. The analysis techniques were applied to the spectra of several bodies in preparation for their application of near-earth asteroids. In mid-November 1989, near-IR observations of three near-earth atseroids, 1865 Cerberus, 1989 VA, and 1989 VB, were made. These asteroids were observed in six broadband visual and near-IR filters (0.4 to 2.5 microns), and a few narrowband measurements in the IR were obtained, but the asteroids were too faint to measure beyond 2.5 microns. Simultaneous, high-resolution visual CCD spectra were measured for these objects, but the data were not yet reduced to determine their quality. Narrowband spectra of the Martian satellite Deimos in the 1 to 3 micron spectral region were obtained. Simultaneous with the observing project, laboratory studies of meteorites and meteorite analogs which are used in spectral analysis of the telescopic data are continuing to be performed. Extensive work was performed in developing applications of Hapke reflectance theory to compositional analysis. Hapke theory is an adaptation of radiative reflectance theory to particulate surfaces. Author

N91-25243*# Arizona Univ., Tucson. Dept. of Mining and Geological Engineering.
CONTINUOUS MONITORING OF THE LUNAR OR MARTIAN SUBSURFACE USING ON-BOARD PATTERN RECOGNITION AND NEURAL PROCESSING OF ROVER GEOPHYSICAL DATA **c91**
J. W. McGill, C. E. Glass, and B. K. Sternberg *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 10 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 03B

The ultimate goal is to create an extraterrestrial unmanned system for subsurface mapping and exploration. Neural networks are to be used to recognize anomalies in the profiles that correspond to potentially exploitable subsurface features. The ground penetrating radar (GPR) techniques are likewise identical. Hence, the preliminary research focus on GPR systems will be directly applicable to seismic systems once such systems can be designed for continuous operation. The original GPR profile may be very complex due to electrical behavior of the background, targets, and antennas, much as the seismic record is made complex by multiple reflections, ghosting, and ringing. Because the format of the GPR data is similar to the format of seismic data, seismic processing software may be applied to GPR data to help enhance the data. A neural network may then be trained to more accurately identify anomalies from the processed record than from the original record. Author

N91-25244*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
A FIGURE-OF-MERIT APPROACH TO EXTRATERRESTRIAL RESOURCE UTILIZATION **c12**
K. Ramohalli and T. Kirsch *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 16 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 22A

A concept is developed for interrelated optimizations in space missions that utilize extraterrestrial resources. It is shown that isolated (component) optimizations may not result in the best mission. It is shown that substantial benefits can be had through less than the best propellants, propellant combinations, propulsion hardware, and actually, some waste in the traditional sense. One ready example is the possibility of discarding hydrogen produced extraterrestrially by water splitting and using only the oxygen to burn storable fuels. The gains in refrigeration and leak-proof equipment mass (elimination) outweigh the loss in specific impulse. After a brief discussion of this concept, the synthesis of the four major components of any future space mission is developed. The four components are: orbital mechanics of the transportation; performance of the rocket motor; support systems that include power; thermal and process controls, and instruments; and in situ resource utilization plant equipment. This paper's main aim is to develop the concept of a figure-of-merit for the mission. The Mars Sample Return Mission is used to illustrate the new concept. At this time, a popular spreadsheet is used to quantitatively indicate the interdependent nature of the mission optimization. Future prospects are outlined that promise great economy through extraterrestrial resource utilization and a technique for quickly evaluating the same. Author

N91-25245*# Arizona Univ., Tucson. Dept. of Nuclear and Energy Engineering.
ENERGY MANAGEMENT ANALYSIS OF LUNAR OXYGEN PRODUCTION
R. Fazzolari and B. G. Wong-Swanson *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 6 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 07D

Energy load models in the process of hydrogen reduction of ilmenite for lunar oxygen production are being developed. The load models will be used as a first step to ultimately determine the optimal energy system needed to supply the power

requirements for the process. The goal is to determine the energy requirements in the process of hydrogen reduction of ilmenite to produce oxygen. The general approach is shown, and the objectives are to determine the energy loads of the processes in the system. Subsequent energy management studies will be made to minimize the system losses (irreversibilities) and to design optimal energy system power requirements. A number of processes are being proposed as possible candidates for lunar application and some detailed experimental efforts are being conducted within this project at the University of Arizona. Priorities are directed toward developing the energy models for each of the proposed processes being considered. The immediate goals are to identify the variables that would impact energy requirements and energy sources of supply. Author

N91-25246*# Arizona Univ., Tucson. Planetary Sciences Inst.
DATA BASE ON PHYSICAL OBSERVATIONS OF NEAR-EARTH ASTEROIDS AND ESTABLISHMENT OF A NETWORK TO COORDINATE OBSERVATIONS OF NEWLY DISCOVERED NEAR-EARTH ASTEROIDS **c90**
D. R. Davis, C. R. Chapman, and H. Campins *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 2 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 03B

This program consists of two tasks: (1) development of a data base of physical observations of near-earth asteroids and establishment of a network to coordinate observations of newly discovered earth-approaching asteroids; and (2) a simulation of the surface of low-activity comets. Significant progress was made on task one and, and task two was completed during the period covered by this progress report. Author

N91-25247*# BDM International, Inc., Albuquerque, NM.
ENGINEERING, CONSTRUCTION, AND OPERATIONS IN SPACE **c90**
Stewart W. Johnson, ed. and John P. Wetzel, ed. *In* Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources New York, NY American Society of Civil Engineers 1990 18 p Proceedings held in Albuquerque, NM, 29-31 Aug. 1988; sponsored in part by NASA, Johnson Space Center, ASCE, AIAA, Society of American Military Engineering, Space Studies Inst., AF, Army Prepared in cooperation with Bechtel International Corp., San Francisco, CA, and Lovelace Scientific Resources, Inc., Albuquerque, NM (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 03B

The century-old Mond process for carbonyl extraction of metals from ore shows great promise as an efficient low energy scheme for producing high-purity Fe, Ni, Cr, Mn, and Co from lunar or asteroidal feedstocks. Scenarios for winning oxygen from the lunar regolith can be enhanced by carbonyl processing of the metallic alloy by-products of such operations. The native metal content of asteroidal regoliths is even more suitable to carbonyl processing. High-purity, corrosion resistant Fe and Ni can be extracted from asteroidial feedstocks along with a Co-rich residue containing 0.5 percent platinum-group metals. The resulting gaseous metal carbonyl can produce a variety of end products using efficient vapor forming techniques. Author

N91-25248*# Washington Univ., Saint Louis, MO. Dept. of Earth and Planetary Sciences.
LUNAR OXYGEN AND METAL FOR USE IN NEAR-EARTH SPACE: MAGMA ELECTROLYSIS **c91**
Russell O. Colson and Larry A. Haskin *In* Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 9 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 03B

Because it is energetically easier to get material from the Moon to Earth orbit than from the Earth itself, the Moon is a potentially valuable source of materials for use in space. The unique conditions on the Moon, such as vacuum, absence of many reagents common on the Earth, and the presence of very nontraditional ores suggest that a unique and nontraditional process for extracting materials from the ores may prove the most practical. With this in mind, an investigation of unfluxed silicate electrolysis as a method for extracting oxygen, iron, and silicon from lunar regolith was initiated and is discussed. The advantages of the process include simplicity of concept, absence of need to supply reagents from Earth, and low power and mass requirements for the processing plant. Disadvantages include the need for uninterrupted high temperature and the highly corrosive nature of the high-temperature silicate melts which has made identifying suitable electrode and container materials difficult. Author

N91-25249*# Washington Univ., Saint Louis, MO. Dept. of Earth and Planetary Sciences.
LUNAR RESOURCES: TOWARD LIVING OFF THE LUNAR LAND **c91**
Larry A. Haskin and Russell O. Colson *In* Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 15 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 03B

The following topics are addressed: (1) lunar resources and surface conditions; (2) guidelines for early lunar technologies; (3) the lunar farm; (4) the lunar filling station; (5) lunar construction materials; (6) the lunar power company; (7) the electrolysis of molten silicate as a means of producing oxygen and metals for use on the Moon and in near-Earth space. K.S.

N91-25250*# National Inst. of Standards and Technology, Boulder, CO. Chemical Engineering Science Div.
IGNITION CHARACTERISTICS OF THE NICKEL-BASED ALLOY UNS N07001 IN PRESSURIZED OXYGEN
J. W. Bransford and P. A. Billiard Sep. 1990 53 p Sponsored by NASA. Prepared in cooperation with Boeing Co.
(NASA-CR-188223; NAS 1.26:188223; PB91-144428; NISTIR-3947) Avail: NTIS HC/MF A04 CSCL 21B

The development of ignition and combustion in pressurized oxygen atmospheres was studied for the nickel-based alloy UNS N07001. Ignition of the alloy was achieved by heating the top surface of a cylindrical specimen with a continuous-wave CO2 laser. Two heating procedures were used. In the first, laser power was adjusted to maintain an approximately linear increase in surface temperature. In the second, laser power was periodically increased until autoheating (self-heating) was established. It was found that the alloy would autoheat to combustion from temperatures below the solidus temperature. In addition, the alloy had a tendency to develop combustion zones (hot spots) at high oxygen pressures when the incremental (step) heating test mode was used. Unique points on the temperature-time curves that describe certain events are defined and the temperatures at which these events occur are given for the oxygen pressure range of 1.72 to 13.8 MPa (250 to 2000 psia). GRA

N91-25251# Chicago Univ., IL. Dept. of Chemical Engineering.
PHASE EQUILIBRIUM OF MIXTURES CONSISTING OF MOLECULES WITH LARGE SIZE AND SHAPE DIFFERENCES (THERMODYNAMIC MODELING OF SUPERCRITICAL FLUID EXTRACTION AND RETROGRADE CONDENSATION, SFE/RC)
Annual Report, Apr. 1987 - Apr. 1988
G. A. Mansoon Aug. 1988 88 p
(Contract GRI-5086-260-1244)
(PB91-144626; GRI-88/0360) Avail: NTIS HC/MF A05 CSCL 07D

Published papers are presented on GRI-supported work to develop accurate techniques for calculation of the thermodynamic properties of asymmetric mixtures. The topics covered include: statistical mechanical description of supercritical fluid extraction and retrograde condensation; conformality of the Kirkwood-Buff solution theory of statistical mechanics; dense fluid theory of mixtures; mean density approximation and hard sphere expansion theory; and the role of three-body forces and mixing rules on the

phase behavior of mixtures VLE (vapor liquid equilibrium) and VLLE calculations. GRA

N91-25252# California Univ., Berkeley. Dept. of Mechanical Engineering.
FIRE PROPAGATION IN CONCURRENT FLOWS Final Report, 1 Aug. 1989 - 31 Jul. 1990
A. C. Fernandez-Pelio Dec. 1990 133 p
(Grant NANB-7-D-0737)
(PB91-157206; NIST/GCR-90/586) Avail: NTIS HC/MF A07 CSCL 21B

A research program is being conducted to study the mechanisms controlling the spread of fire in turbulent forced gas flows moving in the direction of flame propagation. The research tasks completed during the reporting period include experimental studies of the effect of flow turbulence on the rate of concurrent flame spread, and of mass burning when the combustible material is in a floor configuration. The results of the experiments with thick PMMA (polymethyl methacrylate) sheets show that flow turbulence affects significantly the flame spread and mass burning processes. As the turbulence intensity is increased, the flame spread rate decreases because the flame length sharply decreases, and the mass burning rate increases because the surface heat flux increases. Currently underway is a complementary study with the combustible material placed in a ceiling geometry to observe the effect of buoyancy on the flame spread and mass burning processes. An additional task also completed during the period is a review of the processes of ignition and flame spread of solid combustibles. The review presents a novel approach to the analysis and prediction of both processes based on their close interrelationship. GRA

N91-25253# Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.
PULSE COMBUSTION ENGINEERING RESEARCH LABORATORY Annual Report, 1 Sep. 1989 - 31 Aug. 1990
B. T. Zinn, B. R. Daniel, and J. I. Jagoda Oct. 1990 31 p
(Contract GRI-5089-260-1839)
(PB91-157271; GRI-90/0263) Avail: NTIS HC/MF A03 CSCL 21B

Progress made in setting up a Pulse Combustion Engineering Research Laboratory in the School of Aerospace Engineering at Georgia Tech is described. The laboratory will be equipped with modern diagnostic capabilities for investigating pulsating combustion, fluid mechanics, and transport processes. Initial investigations carried out during the first contract year have dealt with the experimental determination of the driving and damping provided by a typical mixing chamber assembly as used in gas fueled, valved, Helmholtz type pulse combustors. An impedance tube technique was used to carry out these measurements. To date, the results obtained indicate that the driving provided by the combustion process is just sufficient to overcome the damping by the valve assembly. In addition, an acoustic model of the valve was developed and used to predict the effect of the non-linearities upon the operation of the pulse combustor. A review of the literature dealing with the mass and heat transfer to and from individual droplets was carried out and the results were used to plan a part of next year's research program, which deals with the effect of pulsations upon drying and calcining. GRA

N91-25254*# Alabama Univ., Huntsville. Dept. of Chemistry.
FOURIER TRANSFORM INFRARED AND RAMAN SPECTROSCOPIC CHARACTERIZATION OF HOMOGENEOUS SOLUTION CONCENTRATION GRADIENTS NEAR A CONTAINER WALL AT DIFFERENT TEMPERATURES Final Technical Progress Report, period ending 31 Mar. 1991
B. H. Loo, D. H. Burns, Y. G. L. Lee, and M. T. Emerson 1991 32 p
(Grant NAG8-089)
(NASA-CR-188541; NAS 1.26:188541) Avail: NTIS HC/MF A03 CSCL 07D

Fourier transform infrared (FTIR) and Raman spectroscopic techniques were used to study the solution concentration gradient in succino nitrile-rich and water-rich homogeneous solutions. The spectroscopic data shows significant concentration dependency. Although FTIR-attenuated total reflectance could not yield surface spectra since the evanescent infrared wave penetrated deep into the bulk solution, it showed that water-rich clusters were decreased at higher temperatures. This result is consistent with the calorimetric results reported earlier. Author

N91-25255# Technische Univ., Delft (Netherlands). Faculty of Chemical Technology and Materials Science.
REGENERATIVE SULFUR CAPTURE IN FLUIDIZED BED COMBUSTION OF COAL: A FIXED BED SORPTION STUDY Ph.D. Thesis
Ericus Henricus Petr Wolff 1991 189 p Sponsored in part by Shell Internationale Petroleum Maatschappij B.B.
(Contracts EN3F-0014-NL(GDF); NOVEM-20-35-016-30; STW-DST77-1386)
(ISBN-90-6275-664-6; ETN-91-99426) Copyright Avail: NTIS HC/MF A09

A low temperature regeneration process based on a synthetic sorbent which combines a relative low regeneration temperature (850 C) with a high particle stength is investigated. Regeneration of the sorbent used to remove sulfur oxides in fluidized bed combustion, a technique to produce energy from coal, enables multicyclic utilization to reduce the quantity of solid waste to be disposed. A sorbent (type/code SG105) consisting of CaO (8.2 wt percent) on 3.1 mm lambda-Al2O3 support, which is prepared by the sol-gel method, is used. After calcination at 850 C, active calcium aluminates are formed. The chemistry and kinetics of cyclic sulfation and regeneration are tested in a fixed bed reactor. Regeneration is found to be a fast process and it is less attractive to use CO than H. A shrinking unreacted core model (SURE2) is proposed to describe the sulfation process. Electron probe X-ray microanalysis of the SG105 sorbent provides an extra validation for the validity of the SURE2 model. Single particle crusting strength tests show that SG105 is much stronger than (calcined) limestone. Multiparticle fluidized bed tests show that a thermal shock from ambient temperature to 850 C, applied to lime or SG105, causes a negligible net mass reduction of the fraction 2.8 to 3.4 mm. An economic analysis shows that the cost of SO2 removal using the regenerative process proposed increases about three times compared with a once through process using conventional sorbent. ESA

N91-25256# Technische Univ., Delft (Netherlands).
MATHEMATICAL MODELLING OF SWIRLING PULVERIZED COAL FLAMES Ph.D. Thesis
Bastiaan Marinus Visser 1991 205 p Sponsored by Netherlands Agency for Energy and Environment and International Flame Research Foundation
(ETN-91-99435) Avail: NTIS HC/MF A10

The development and application of a mathematical model to account for all the important processes occurring in the combustion zone is presented. This model is to be used for research into the reduction of the generation of pollutants in the combustion zone. It will be a powerful tool for both determination of the missing information at experimental scale and for scaling up experiments. The model is based on a three dimensional simulation for turbulent flow computations and should be accompanied by models of combustion and heat transfer. Various aspects of the modeling are investigated. The results of these investigations are used in a study of the characteristics of flames fired with a pulverised coal burner. ESA

N91-25257# Wyoming Univ., Laramie. Dept. of Chemistry.
SOLID-SURFACE LUMINESCENCE ANALYSIS
R. J. Hurtubise 1991 5 p
(Contract DE-FG02-86ER-13547)
(DE91-010000; DOE/ER-13547/2) Avail: NTIS HC/MF A01

Several fundamental luminescence parameters were calculated for model compounds on beta cyclodextrin/salt mixtures. A number of correlations were developed for the interactions of the model compounds with the beta-CD matrices. With model compounds

adsorbed on filter paper, several basic equations were developed that relate radiative and nonradiative rate constants to activation energies. These equations will be important in defining specific processes that occur in filter paper. The modulus of filter paper has been related to various luminescence processes of the adsorbed compounds. Also, it has been possible to develop linear equations that relate the modulus of filter paper to the phosphorescence lifetimes of the adsorbed compounds. DOE

N91-25258# California Univ., Berkeley. Lawrence Berkeley Lab.
EX-SITU AND IN-SITU SPECTROSCOPIC STUDIES OF THE PASSIVE FILM ON LITHIUM IN NON-AQUEOUS SOLVENTS
D. A. Scherson and G. S. Chottiner (Case Western Reserve Univ., Cleveland, OH.) Oct. 1990 22 p
(Contract DE-AC03-76SF-00098)
(DE91-010227; LBL-29697) Avail: NTIS HC/MF A03

The main aim of this research is to elucidate the structure and composition of lithium-non-aqueous solvent passive films by using an array of ex-situ and in-situ spectroscopic techniques including Auger Electron and X-ray Photoelectron Spectroscopies (AES and XPA, respectively), temperature programmed desorption (TPD), and Fourier Transform Reflection Absorption Infrared Spectroscopy (FTIRRAS). Attention during this past year has been focused on the reaction of tetrahydrofuran (THF) with lithium. DOE

N91-25259# Massachusetts Inst. of Tech., Cambridge. Dept. of Chemical Engineering.
AROMATICS OXIDATION AND SOOT FORMATION IN FLAMES
J. B. Howard 1990 5 p
(Contract DE-FG02-84ER-13282)
(DE91-010262; DOE/ER-13282/8) Avail: NTIS HC/MF A01

Work at MIT during this contract period has been concerned with kinetics and mechanisms of aromatics oxidation and soot formation in flames. The scope includes detailed measurements of profiles of stable and radical species concentrations and soot-particle number concentration and size distribution through the reaction zone of low-pressure one-dimensional premixed flames. Intermediate species identifications and mole fraction, flux, and net reaction rates calculated from the profile measurements are used to test postulated reaction mechanisms. The aromatics oxidation work is focused mainly on benzene, and the soot formation work is primarily concerned with the particle inception or nucleation stage. Particular objectives are to identify and to determine rate constants for the main benzene oxidation reactions in flames, and to characterize the soot precursor species and the mechanisms and kinetics of the transition from molecules to nascent soot particles. DOE

N91-25260# Georgia Tech Research Inst., Atlanta.
THEORETICAL STUDIES OF HYDROCARBON COMBUSTION CHEMISTRY
H. F. Schaefer, III Jan. 1991 32 p
(Contract DE-FG09-87ER-13811)
(DE91-010620; DOE/ER-13811/4) Avail: NTIS HC/MF A03

In surveying the literature of methane and ethane oxidation, one discovers quickly that the reactions of atomic oxygen have been much more thoroughly characterized experimentally than the analogous reactions of molecular oxygen. The reason, of course, is that molecular oxygen frequently dissociates at the relatively high temperatures at which combustion takes place and atomic oxygen is indeed a very important species. The essence of the present proposal is that theoretical studies of the reactions of molecular oxygen would be very useful. Molecular oxygen is abundant in combustion processes, its reactions with simple hydrocarbons are not well understood, and the area represents something of a question mark for the whole field. A theoretical study was completed of CH4 + O2 and are just beginning research on the C2H5 + O2 system. DOE

N91-25261# Oak Ridge Y-12 Plant, TN.
FAST, HIGH-RESOLUTION X RAY MICROFLUORESCENCE IMAGING
D. A. Carpenter and M. A. Taylor 15 Aug. 1990 10 p Presented at the 39th Annual Denver X Ray Conference, Steamboat Springs, 30 Jul. - 3 Aug. 1990
(Contract DE-AC05-84OS-21400)
(DE91-010658; Y/DW-983; CONF-9007149-7) Avail: NTIS HC/MF A02

X ray microfluorescence imaging refers to the use of an x ray beam as a probe to excite X Ray Fluorescence (XRF) in a specimen and produce a spatially resolved image of the element distribution. The advantages of high sensitivity and low background, together with the nondestructive nature of the measurement, have led to applications of x ray microfluorescence analysis in biology, geology, materials science, as well as in the area of nondestructive evaluation. Previous reports have described the development of an x ray microprobe which uses a conventional source of x rays to produce a 10-micron beam. This paper describes improvements to the microprobe which have increased the beam power and the solid angle of detection. The data collection and display software have also been enhanced. DOE

N91-25262# Cincinnati Univ., OH.
SURFACE CHEMISTRY OF ELECTROCATALYSTS
A. T. Hubbard 1990 32 p
(Contract DE-FG02-86ER-45247)
(DE91-010850; DOE/ER-45247/4) Avail: NTIS HC/MF A03

Sections are presented which described the following topics: (1) Electrodeposition of lead at Pt(111) surfaces; (2) surface electrochemistry of adsorbed sulfur compounds; (3) influence of surface structure on adsorption and electrolysis; (4) quantitation of molecular layers by Auger spectroscopy; and, (5) electron energy-loss spectroscopy of electrode surfaces. DOE

N91-25263# Lawrence Livermore National Lab., CA.
OPTICAL AND THERMAL ENERGY DISCHARGE FROM TRITIATED SOLID HYDROGEN
F. Magnotta, E. R. Mapoles, G. W. Collins, and P. C. Souers 2 Apr. 1991 9 p Presented at the Air Force High Energy Density Materials Contractors Conference, Albuquerque, 24-27 Feb. 1991
(Contract W-7405-eng-48)
(DE91-011188; UCRL-JC-106507; CONF-9102109-1) Avail: NTIS HC/MF A02

Mechanisms of energy storage and release in tritiated solid hydrogens, by a variety of techniques including ESR, NMR, and thermal and optical emission are investigated. The nuclear decay of a triton in solid hydrogen initiates the conversion of nuclear energy into stored chemical energy by producing unpaired hydrogen atoms which are trapped within the molecular lattice. The ability to store large quantities of atoms in this manner has been demonstrated and can serve as a basis for new forms of high energy density materials. This paper presents preliminary results of a study of the optical emission from solid hydrogen containing tritium over the visible and near infrared (NIR) spectral regions. Specifically, they have studied optical emission from DT and T(sub 2) using CCD, silicon diode, and germanium diode arrays. DOE

N91-25264# Los Alamos National Lab., NM.
MEASUREMENT OF TRACE ISOTOPES BY PHOTON BURST MASS SPECTROMETRY
W. M. Fairbank, Jr., C. S. Hansen, R. D. LaBelle, X. J. Pan (Colorado State Univ., Fort Collins.), E. P. Chamberlin, B. L. Fearcy, R. E. Gritzo, R. A. Keller, C. M. Miller, and H. Oona 1991 5 p Presented at the OE/LASE '91: 4th Society of Photo-Optical Instrumentation Engineers (SPIE) International Symposium, Los Angeles, 20-25 Jan. 1991
(Contract W-7405-eng-48)
(DE91-011397; LA-UR-91-1131; CONF-910123-24) Avail: NTIS HC/MF A01

Progress is reported on the development of a new laser- and mass spectrometer-based technique for measurement of trace levels of radioisotopes. Significant results to date include the demonstration of high efficiency and throughput in a mass spectrometer, efficient production of metastable atoms from Ar(+)

and Kr(+) beams, a demonstration of the photon burst detector principle with Mg(+) ions, and the verification of zero background in a two-detector system. DOE

N91-25265# Babcock and Wilcox Co., Alliance, OH.
NUMERICAL MODELING APPLICATIONS FOR GAS COMBUSTION SYSTEMS Final Report, Jul. 1989 - Jul. 1990
W. A. Fiveland Aug. 1990 94 p
(Contract GRI-5089-260-1808)
(PB91-159541; GRI-90/0244) Avail: NTIS HC/MF A05 CSCL 21B

Research was undertaken to determine the modeling needs of the natural gas combustion industry and to prepare a plan to develop a comprehensive combustion model. The needs of manufacturers were determined by polling 31 developers in the U.S. and Europe. A review is given of available codes. Code abstracts are listed. Methods used in the codes to model flow, combustion, and heat transfer are reviewed. Author

N91-25266# Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.
RESEARCH ON COMBUSTION PROCESSES ASSOCIATED WITH NATURAL GAS USED AS AN INTERNAL COMBUSTION ENGINE FUEL Final Report, May 1988 - Jul. 1990
P. D. Ronney Jul. 1990 42 p
(Contract GRI-5088-260-1688)
(PB91-161240; GRI-0242) Avail: NTIS HC/MF A03 CSCL 21B

Assessed here are the mechanisms responsible for the observed ignition, flammability, stability, and knock limits in natural gas fueled internal combustion engines, particularly in strongly turbulent flows, and to devise ways to improve natural gas engine performance based on these findings. Author

26 METALLIC MATERIALS

Includes physical, chemical, and mechanical properties of metals, e.g., corrosion; and metallurgy.

N91-25267 California Univ., San Diego.
HIGH-STRAIN-RATE PLASTIC FLOW IN METALLIC SINGLE CRYSTALS Ph.D. Thesis
Mark Marwan Rashid 1990 202 p
Avail: Univ. Microfilms Order No. DA9110712

A numerical algorithm is developed for the integration of the constitutive equations of rate-dependent crystal plasticity theory. The algorithm is based on a weighted residual method, and employs a modified Newton-Raphson iterative solver to achieve reliable and efficient convergence. The algorithm has been implemented in an explicit finite element code for the purposes of analyzing the response of face-centered cubic crystals to high-strain-rate deformations. This finite element code was used to simulate the deformation of carefully oriented copper single crystals that were dynamically indented using the split Hopkinson pressure bar. In the experiment, slab-like crystals were subjected to a high-rate edge-indentation by means of a precisely contoured indenter. For comparison, one specimen was subjected to a similar, but quasistatic, edge-indentation. Scanning electron microscopy performed on the deformed specimens revealed that plastic flow occurred by crystallographic slip on a pair of slip systems oriented approximately 70 degrees apart. Additionally, the quasistatic specimen exhibited bands of concentrated deformation that were absent from the dynamically deformed crystals. The comparison between the computational and experimental results indicates that proper characterization of the rate-dependence of plastic flow is crucial if realistic numerical predictions are to be obtained. In particular, both the computational and the experimental results indicate that the formation of localized modes of deformation is extremely sensitive to strain rate history effects. Accordingly, a Hopkinson bar experiment is proposed for the separation and measurement of instantaneous rate sensitivity and strain rate history effects. Also, a new theoretical framework for the plastic flow of metallic single crystals is developed. This construct takes explicit account of the dislocation structure responsible for inelastic deformation through the use of dislocation distribution functions. Dissert. Abstr.

N91-25268 Auburn Univ., AL.
HYDROGEN-INDUCED FRACTURE CHARACTERISTICS OF SINGLE CRYSTAL NICKEL-BASED SUPERALLOY Ph.D. Thesis
Po-Shou Chen 1990 238 p
Avail: Univ. Microfilms Order No. DA9109043

A stereoscopic method was developed and applied to the fracture surface of PWA 1480E single crystal nickel-based superalloy to permit rapid orientation determinations of small cleavage planes. The microstructure of PWA 1480E was characterized before fracture analysis was performed. The bucoid morphology of the gamma prime precipitate was not influenced by the crystal growth orientation. The amount of lattice mismatch and lattice misorientation between gamma/gamma prime in PWA 1480E was not affected by the single crystal growth orientation. Notched single crystals with seven different crystal growth orientations were tensile tested at room temperature in a helium atmosphere at 34 MPa, and notched single crystals with seven different crystal growth orientations were also tensile tested at room temperature in a hydrogen atmosphere at 34 MPa. In order to understand the temperature dependence of hydrogen-induced embrittlement, notched single crystals with three different crystal growth orientations were tensile tested at 1600 F in helium and hydrogen atmospheres at 34 MPa. Results of the environmentally controlled tests are given and briefly discussed. Dissert. Abstr.

N91-25269*# Illinois Inst. of Tech., Chicago. School of Advanced Studies.
RAPID SOLIDIFICATION OF HIGH-CONDUCTIVITY COPPER ALLOYS Ph.D. Thesis
Theodore Atlas Bloom Aug. 1989 212 p
(Grant NAG3-409)
(NASA-CR-188614; NAS 1.26:188614) Avail: NTIS HC/MF A10 CSCL 11F

The main objective was to develop improved copper alloys of high strength and high thermal and electric conductivity. Chill block melt spinning was used to produce binary alloys of Cu-Cr and Cu-Zr, and ternary alloys of Cu-Cr-Ag. By quenching from the liquid state, up to 5 atomic percent of Cr and Zr were retained in metastable extended solid solution during the rapid solidification process. Eutectic solidification was avoided and the full strengthening benefits of the large volume fraction of precipitates were realized by subsequent aging treatment. The very low solid solubility of Cr and Zr in Cu result in a high conductivity Cu matrix strengthened by second phase precipitates. Tensile properties on as-cast and aged ribbons were measured at room and elevated temperatures. Precipitate coarsening of Cr in Cu was studied by changes in electrical resistance during aging. X-ray diffraction was used to measure the lattice parameter and the degree of supersaturation of the matrix. The microstructures were characterized by optical and electron microscopy. Author

N91-25270# Oak Ridge National Lab., TN.
PROCESSING AND MECHANICAL PROPERTIES OF NI3AI-BASED INTERMETALLIC COMPOSITES
V. K. Sikka, E. K. Ohriner, and L. F. Allard 1991 9 p Presented at the Symposium on Powder Metallurgy in Aerospace and Defense Technologies, Tampa, 4-6 Mar. 1991
(Contract DE-AC05-84OR-21400)
(DE91-009932; CONF-910343-1) Avail: NTIS HC/MF A02

The fabrication, microstructures, and properties of nickel-aluminide-based composites are described. In all cases, the composites were examined as-fabricated and after exposure for 100 h at a temperature of 1100 C. The thermal exposure was used to check for reactions and thermal stability of the reinforcement. The thermally stable and inert reinforcements for the Ni3Al matrix are NbC, TiC, HfN, and TiN. The TiC composite through XD(trademark) addition appears to enhance the cast properties at room temperature and high temperature, and can

probably be used for certain cast applications. The most recent work on Ni3Al-based composites using NbC, HfN, and TiN particulates showed no significant strengthening. Thus, the only hope for beneficial reinforcement appears to be the TiC through XD(trademark) addition. All of the fabrication methods described appear to be viable processes for making Ni3Al-based composites. Recent data confirms that TiC additions to Ni3Al via powder metallurgy increases its strength at both low and high temperatures. Thus a combination of the present study and the published data suggest that the Ni3Al composites containing TiC have a potential for commercial use in either cast or wrought condition. DOE

N91-25271# Edgerton, Germeshausen and Grier, Inc., Idaho Falls, ID.
THERMOGRAVIMETRIC EXPERIMENTS WITH TITANIUM
L. J. Porter and G. R. Longhurst Feb. 1991 13 p
(Contract DE-AC07-76ID-01570)
(DE91-010073; EGG-FSP-9499) Avail: NTIS HC/MF A03

In the process of preparing for pyrophoricity experiments involving uranium, hydriding and air exposure experiments were conducted on titanium. In these experiments the hydriding reactions and response to air exposure was generally within the range expected based on work reported by others. One aberrant behavior was a sudden weight gain followed by a significant weight loss. It is speculated that loss may be due to hydrogen evolution from the TiH2 resulting from local heating by oxidation reactions. It was verified that titanium is not pyrophoric at temperatures less than 750 C. DOE

N91-25272# Pacific Northwest Lab., Richland, WA.
MODELING IRRADIATION-INDUCED GRAIN BOUNDARY SEGREGATION IN STAINLESS STEELS
E. P. Simmonen, L. A. Charlot, and S. M. Bruemmer 1991 13 p
(Contract DE-AC06-76RL-01830)
(DE91-010157; PNL-SA-18903) Avail: NTIS HC/MF A03

Irradiation induced segregation of silicon and irradiation induced depletion of chromium near grain boundaries are modeled to evaluate potential influences on irradiation assisted stress corrosion cracking. Model calculations predict that significant silicon enrichments will be established at grain boundaries. However, predicted enrichments exceed measured enrichments. Calculations of chromium depletion are in accord with measured irradiation induced chromium depletion near irradiated grain boundaries. Predicted grain boundary silicon concentrations are greater than a monolayer coverage and the enriched layer is less than 1 nm thick. Chromium concentrations are predicted to decrease by about 50 pct. with a depletion width of several nm. Differences between irradiation induced and thermally induced grain boundary microchemistries are discussed and related to current understanding of interfacial chemistry effects on IGSCC. DOE

N91-25273# Dartmouth Coll., Hanover, NH. School of Engineering.
THE HALL-PETCH RELATIONSHIP AND MECHANISMS OF FRACTURE IN B2 COMPOUNDS
I. Baker 1 Mar. 1991 9 p
(Contract DE-FG02-87ER-45311)
(DE91-010256; DOE/ER-45311/4) Avail: NTIS HC/MF A02

This report is concerned with studies of the Hall-Petch relationship and Mechanisms of fracture in B2 compounds. It covers the period from April 1st 1990 to March 1st 1991. Transition electron microscopy (TES) in-situ straining studies have been performed on NiAl and FeAl. Both materials show intense activity ahead of transgranular cracks in thin foils. Thin foils of NiAl show cell structures after in-situ straining which are very similar to those in samples taken from bulk deformed material. Studies of the fracture behavior as a function of stoichiometry have been completed for both FeAl and NiAl. ALCHEMI studies have been performed on a number of B2 compounds (NiAl + V and FeAl + Cr) and L12 compounds (Ni3Al + Hf and Al3Ti + Ni) in order to determine the site occupancy of the ternary addition. Alloys of CoAl, FeCo, NiAl + B, FeAl + Cr and CuZn have been cast and further processing has been initiated. TEM examination of dislocations in FeCo has been started. DOE

N91-25274# Oak Ridge National Lab., TN.
EFFECTS OF ELASTIC ANISOTROPY ON MECHANICAL BEHAVIOR OF INTERMETALLIC COMPOUNDS
M. H. Yoo 1991 10 p Presented at the 6th Japan Institute of Metals (JIM) International Symposium on Intermetallic Compounds: Structures and Mechanical Properties, Sendai (Japan), 17-20 Jun. 1991
(Contract DE-AC05-84OR-21400)
(DE91-010392; CONF-9106146-1) Avail: NTIS HC/MF A02

Fundamental aspects of the deformation and fracture behavior of ordered intermetallic compounds are examined within the framework of linear anisotropic elasticity theory of dislocations and cracks. The orientation dependence and the tension/compression asymmetry of yield stress are explained in terms of the anisotropic coupling effect of non-glide stresses to the glide strain. The anomalous yield behavior is related to the disparity (edge/screw) of dislocation mobility and the critical stress required for the dislocation multiplication mechanism of Frank-Read type. The slip-twin conjugate relationship, extensive faulting, and pseudo-twinning (martensitic transformation) at a crack tip can be enhanced also by the anisotropic coupling effect, which may lead to transformation toughening of shear type. DOE

N91-25275# Northwestern Univ., Evanston, IL. Dept. of Chemistry.
SUPPORTED ORGANOMETALLIC COMPLEXES: SURFACE CHEMISTRY, SPECTROSCOPY, AND CATALYSIS
T. J. Marks 1991 6 p
(Contract DE-FG02-86ER-13511)
(DE91-010396; DOE/ER-13511/4) Avail: NTIS HC/MF A02

Adsorbing organometallic molecules onto the surfaces of inorganic supports such as Al2O3, MgCl2, SiO2, etc., can result in dramatic enhancements in catalytic activity. The reasons for this and the structures of the resulting surface organometallic centers are not well understood. We have addressed this problem using actinide and early transition metal complexes as model adsorbates. Characterization tools include catalytic and stoichiometric reaction chemistry, reaction kinetics and isotopic labeling, quantitative poisoning studies, model solution chemistry, and a wide array of surface-sensitive spectroscopies as well as titration calorimetry. These chemical and physical experiments are closely coupled to model solution chemistry to provide maximum information yield. DOE

N91-25276# South Carolina Univ., Columbia. Dept. of Chemistry.
THE TRANSFORMATION OF ORGANIC AMINES BY TRANSITION METAL CLUSTER COMPOUNDS
R. D. Adams Jan. 1991 24 p
(Contract DE-FG09-84ER-13296)
(DE91-010622; DOE/ER-13296/7) Avail: NTIS HC/MF A03

Some areas of research on the objectives are as follows: (1) hydrogenation of ynamines by metal cluster complexes; (2) synthesis and characterization of ynamine complexes of dirhenium; (3) ring opening of strained ring thioethers: reaction of thietane with Os3(CO)11)NCMe; reaction of 3,3 dimethylthietane with Os3(CO)10NCMe2; (4) CO splitting: The reaction of Mn2(CO)9NCMe with ynamine; and (5) publications under this project in 1990 are listed. DOE

N91-25277# Sandia National Labs., Albuquerque, NM.
REACTIVE METAL BRAZING OF ALUMINUM NITRIDE
R. K. Brow, R. E. Loehman, and A. P. Tomsia (California Univ., Berkeley.) 1990 7 p Presented at the Fall Meeting of the Minerals, Metals and Materials Society (TMS) on Physical Metallurgy and Materials in Conjunction with Materials Week and the Material Applications and Services Exposition, Detroit, 7-11 Oct. 1990

(Contract DE-AC04-76DP-00789)
(DE91-010867; SAND-90-0791C; CONF-901008-10) Avail: NTIS HC/MF A02

The addition of titanium to eutectic braze compositions causes these alloys to readily wet and bond to AlN ceramics. Electron microscopic characterizations of the metal-ceramic interfaces reveal the presence of TiN, along with other Ti and Al containing phases. The formation of such interfacial reaction products is an additional thermodynamic driving force for the creation of useful metal-ceramic bonds. DOE

N91-25278# Colorado Univ., Boulder.
CHEMISORPTION AND REACTIONS STUDIES ON WELL-CHARACTERIZED BIMETALLIC AND ALLOY SURFACES
B. E. Koel 1990 6 p
(Contract DE-FG02-86ER-13473)
(DE91-010935; DOE/ER-13473/T2) Avail: NTIS HC/MF A02

The following major areas important to understanding bimetallic and alloy surface chemistry and catalysis were investigated: (1) the influence of potassium on the interactions of ethylene and other hydrocarbon species with platinum, (2) the determination of ensemble size requirements for adsorption and reaction on platinum surfaces, (3) the influence of oxygen adatoms on the bonding of nitric oxide to platinum, and (4) the role of the electronic structure of the metal surface in controlling surface chemistry. All of these studies were carried out using surface science techniques on well-characterized metal surfaces. A major effort and a major achievement of work have been to study model systems designed to explain how changes in geometric and electronic structure of metal surfaces affect surface chemistry. Specifically, the influence of potassium and bismuth coadsorption with small molecules on a Pt(111) single crystal surface can be compared to separate electronic effects from those of ensemble size effects. We also report the first measurements of the heat of adsorption of carbon monoxide as a function of Pd film thickness for thin films which have dramatically altered geometric and electronic structure. DOE

N91-25279# Oak Ridge National Lab., TN.
SYNTHESIS OF ATOMISTIC AND CONTINUUM MODELLING OF INTERMETALLIC ALLOYS
C. L. Fu and M. H. Yoo 1991 2 p Presented at the Computational Research on Materials Conference, Morgantown, 15-17 Apr. 1991
(Contract DE-AC05-84OR-21400)
(DE91-011089; CONF-9104224-1) Avail: NTIS HC/MF A01

The mechanistic understanding of yield and flow strengths and brittle fracture behavior of ordered transition-metal aluminides has been critically assessed on the basis of quantum mechanical total-energy calculations, and anisotropic elasticity theory of dislocations and cracks. The bonding mechanism is described by the combination of charge transfer (from Al to transition-metals) and strong p-d hybridization effects. The strong ordering behavior of Ni-base aluminides is attributed to the size difference and electrochemical difference between constituent elements. The calculated (and observed) defect structure of NiAl-constitutional vacancies in Al-rich NiAl, and substitutional defects in Ni-rich NiAl-is well correlated with the proposed bonding mechanism and ordering behavior of aluminides. The ground-state elastic constants, various shear fault energies, and cleavage energies are calculated for aluminides of cubic (L1(sub 2) and B2) and tetragonal (L1(sub 0) and D0(sub 22)) structures. The anomalous yield and flow behavior of Ni3Al is analyzed by means of symmetry considerations and the interaction torque effect on the mobility of superdislocations subjected to generalized applied stress. The calculation suggests that the elastic shear anisotropy is the major driving force underlying the positive temperature dependence of yield strength. The ideal cleavage strength is determined by the surface electronic structure calculation, and the critical stress-intensity factor for Mode-I crack is obtained using the calculated cleavage energies and elastic constants. The reported cleavage habit planes of (110) for NiAl and (100) for FeAl are interpreted in terms of cleavage energy anisotropy and the orientation dependence of crack-tip plasticity. The mechanism underlying the hydrogen-induced embrittlement effect in FeAl is investigated by first-principles total-energy approach. DOE

N91-25280# Argonne National Lab., IL.
QUANTIFICATION OF ATOMIC-SCALE GRAIN BOUNDARY PARAMETERS BY HIGH RESOLUTION ELECTRON MICROSCOPY
K. L. Merkle Mar. 1991 23 p Presented at the Workshop on Structure and Properties of Interfaces, Wickenburg Inn, 2-6 Jan. 1991
(Contract W-31-109-eng-38)
(DE91-011181; ANL/CP-72702; CONF-910197-1) Avail: NTIS HC/MF A03

Recent grain boundary modeling studies in fcc metals have revealed global correlations between GB energy and: (1) the rigid-body translation normal to the grain boundary (the so-called volume expansion); and (2) the degree of deviation of the local atomic coordination across the interface relative to the ideal lattice. This communication describes an approach towards evaluations of such parameters by analyzing images obtained by axial high-resolution electron microscopy, utilizing digital image processing techniques. DOE

N91-25281# Lawrence Livermore National Lab., CA.
FROM ELECTRONIC STRUCTURE TO ALLOY PHASE STABILITY
P. E. A. Turchi, M. Sluiter, F. J. Pinski, D. D. Johnson, and G. M. Stocks (Oak Ridge National Lab., TN.) 27 Feb. 1991 7 p Presented at the 6th Japan Institute of Metals (JIM) International Symposium on Intermetallic Compounds: Structure and Mechanical Properties, Sendai, Japan, 17-20 Jun. 1991
(Contract W-7405-eng-48)
(DE91-011187; UCRL-JC-106784; CONF-9106146-2) Avail: NTIS HC/MF A02

The study of phase stability, including order-disorder phenomena and structural transformations, in substitutional alloys is of great theoretical and technological interest. The goal is to perform ab-initio calculations of thermodynamical properties of alloys. These calculations combine accurate quantum mechanical and statistical descriptions of the total alloy free energy. The study of the interplay between electronic structure properties, crystalline effects, and configurational order, at a microscopic level, will be successfully illustrated for Cu-Zn, Fe-Cr, and Fe-V alloys, thus demonstrating the validity and the predictive power of our advanced methodology. DOE

N91-25282# Pacific Northwest Lab., Richland, WA.
HYDROGEN EMBRITTLEMENT EFFECTS ON TENSILE PROPERTIES OF TUNGSTEN HEAVY ALLOYS
G. B. Dudder and W. E. Gurwell Feb. 1991 8 p Presented at the Annual Meeting and Exhibition of the Minerals, Metals and Materials Society (TMS), New Orleans, 17-21 Feb. 1991
(Contract DE-AC06-76RL-01830)
(DE91-011332; PNL-SA-19072; CONF-910202-13) Avail: NTIS HC/MF A02

The strain rate sensitivities of 93 and 70 percent W heavy metal alloys are characterized in the hydrogen-charged and vacuum-outgassed conditions. In outgassed material, strength increases as ductility decreases with increased strain rate; however, for hydrogen-charged material, both ductility and strength increase with strain rate. Fracture morphology changes from characteristically ductile to brittle as strain rate increases. An integrated model is presented that illustrates the change in fracture behavior with strain rate for ductile, hydrogen-embrittled, and impurity-segregation embrittled material. DOE

N91-25283*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
BRAZE ALLOY PROCESS AND STRENGTH CHARACTERIZATION STUDIES FOR 18 NICKEL GRADE 200 MARAGING STEEL WITH APPLICATION TO WIND TUNNEL MODELS

James F. Bradshaw, Paul G. Sandefur, Jr., and Clarence P. Young, Jr. (North Carolina State Univ., Raleigh.) May 1991 47 p
(NASA-TM-104075; NAS 1.15:104075) Avail: NTIS HC/MF A03 CSCL 11F

A comprehensive study of braze alloy selection process and strength characterization with application to wind tunnel models is presented. The applications for this study include the installation of stainless steel pressure tubing in model airfoil sections make of 18 Ni 200 grade maraging steel and the joining of wing structural components by brazing. Acceptable braze alloys for these applications are identified along with process, thermal braze cycle data, and thermal management procedures. Shear specimens are used to evaluate comparative shear strength properties for the various alloys at both room and cryogenic (-300 F) temperatures and include the effects of electroless nickel plating. Nickel plating was found to significantly enhance both the wetability and strength properties for the various braze alloys studied. The data are provided for use in selecting braze alloys for use with 18 Ni grade 200 steel in the design of wind tunnel models to be tested in an ambient or cryogenic environment. Author

N91-25207*# Arizona Univ., Tucson. Dept. of Materials Science and Engineering.
CHLORINATION PROCESSING OF LOCAL PLANETARY ORES FOR OXYGEN AND METALLURGICALLY IMPORTANT METALS
D. C. Lynch *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 11 p (For primary document see N91-25203 17-25)
Avail: NTIS HC/MF A08 CSCL 11F

N91-25227*# Arizona Univ., Tucson. Lunar and Planetary Lab.
EXTRACTION OF VOLATILE AND METALS FROM EXTRATERRESTRIAL MATERIALS
John S. Lewis *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 7 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 11F

N91-25239*# Arizona Univ., Tucson. Dept. of Chemistry and Strategic Metals Recovery Research Facility.
RECOVERY OF PRECIOUS METALS IN SPACE Abstract Only
H. Freiser *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 1 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 11F

27 NONMETALLIC MATERIALS

Includes physical, chemical, and mechanical properties of plastics, elastomers, lubricants, polymers, textiles, adhesives, and ceramic materials.

For composite materials see *24 Composite Materials.*

N91-25284# National Inst. of Standards and Technology, Gaithersburg, MD. Ceramics Div.
CERAMICS: TECHNICAL ACTIVITIES, 1990
Nov. 1990 170 p
(PB91-132233; NISTIR-4394) Avail: NTIS HC/MF A08 CSCL 11C

Current programs of the Ceramics Division are reviewed. In 1990 technology transfer was accomplished by the preparation and publication of 180 papers, the presentation of 150 talks, and the submission of six invention disclosures. The Structural Ceramics Database Version 1.0, which contains evaluated thermomechanical data for industrial designers, was offered for public distribution by the Office of Standard Reference Data. Other database activities continued with the distribution of A Computerized Tribology Information System (ACTIS) and the completion of volumes 7 and 8 of the National Institute of Standards and Technology/American Ceramic Society Phase Diagrams for Ceramists. An assessment of diamond technology in Japan was undertaken. Also discussed is research in ceramic slurries, structural fatigue, and superconductors. Author

N91-25285 Rensselaer Polytechnic Inst., Troy, NY.
CHARACTERIZATION OF CARBON OVERCOATS AND OTHER SURFACE LAYERS ON TRIBOLOGICAL SURFACES Ph.D. Thesis
Leon Philip DuPlessis, III 1990 274 p
Avail: Univ. Microfilms Order No. DA9111056

The tribological characteristics of carbon-coated computer hard disks and lubricating carbon formed from organic gases were analyzed. The primary tool used to analyze the carbon deposits on these tribological surfaces was Raman spectrophotometry. Ellipsometry was used to measure the thicknesses and optical constants of the materials on the carbon-coated computer hard disks. Infrared Fourier transform emission spectroscopy and fluorescence was investigated to determine the feasibility of measuring the concentration and uniformity of the perfluoropolyether used to lubricate the carbon surface of these computer hard disks. Masks were developed to improve the spatial resolution of emission spectroscopy. Dissert. Abstr.

N91-25286*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
LONG TERM ISOTHERMAL AGING AND THERMAL ANALYSIS OF N-CYCAP POLYIMIDES
James K. Sutter, John F. Waters, and Marla A. Schverman (Xavier Univ., Cincinnati, OH.) 1991 8 p Presented at the High Performance Materials Symposium at the Polymer Technology Conference, Philadelphia, PA, 3-5 Jun. 1991; sponsored by the American Chemical Society
(NASA-TM-104341; E-6115; NAS 1.15:104341) Avail: NTIS HC/MF A02 CSCL 11C

The N-CYCAP polyimides utilize a (2,2) paracyclophane endcap that polymerizes and does not generate volatile gases during the cure process. These polyimides have both high glass temperatures (390 C) and an onset of decomposition in air of 560 C. Thermal oxidative stability (TOS) weight loss studies show that replacing 25 percent by weight of the paraphenylene diamine in the polymer backbone with metaphenylene diamine improves the weight loss characteristics. N-CYCAP neat resin samples performed better than PMR-II-50 when exposed at 343 and 371 C in air for up to 1000 hours. Preliminary composite studies show that both PMR-II-50 and N-CYCAP have better thermal stability when fabricated on T-40R. Higher isothermal aging temperatures of longer aging times are needed to determine the differences in TOS between composite samples of PMR-II-50 and N-CYCAP polyimides. Author

N91-25287# National Aerospace Lab., Tokyo (Japan).
APPLICATION OF BRITTLE LACQUER TECHNIQUES TO THE STRENGTH TEST OF CFRP SPAR/RIB ELEMENT
Toshio Nohara and Koichi Egawa Dec. 1990 23 p In JAPANESE; ENGLISH summary
(NAL-TR-1089; ISSN-0389-4010) Avail: NTIS HC/MF A03

Research was conducted to find a technique for applying brittle lacquer coating in a large experimental area in which, for example, a large airplane can be tested. The brittle lacquer coating method has the advantages of easy application, even on complicated shaped structures, and of easy discovery of stress distribution, especially for the direction of principal stresses, in a wide area. But it requires comparatively strict temperature and humidity control in drying the sprayed lacquer, and one can not easily satisfy those conditions in a large experimentation area. So initial research was conducted to find a selection standard for a suitable lacquer for use where temperature and humidity are not controlled. Then to verify the validity of the selection standard, the stress distribution of several models of spars and ribs of airplane structure made of carbon fiber reinforced plastic and coated with brittle lacquer selected by the standard was measured. The utility of the new method was clarified by these experimental results. Author

N91-25288# Technische Univ., Delft (Netherlands).
A SURVEY ON THE MECHANISMS AND MECHANICS OF TOUGHNING IN STRUCTURAL CERAMICS
G. T. M. Stam, E. vanderGiessen, and P. Meijers 1990 51 p
(MEMT-15; ISBN-90-370-0049-5; ETN-91-99437) Copyright
Avail: NTIS HC/MF A04

Ceramics are used more and more in structural applications. The most common difficulty of ceramics is their brittleness. Much research has been devoted to toughen ceramics. A survey on the research performed, looked at from a mechanics point of view, is given. The toughening mechanisms discussed include transformation and microcrack toughening, as well as toughening by ductile particles or fibers. The combination of two or more toughening mechanisms is of particular interest. Preliminary, investigations indicate the possibility of synergetic effects. ESA

N91-25289# Oak Ridge National Lab., TN.
DETERMINATION OF HIGH TEMPERATURE CREEP PARAMETERS IN STRUCTURAL CERAMICS FROM CONSTANT-DISPLACEMENT, LOAD-RELAXATION TESTS
M. G. Jenkins and M. K. Ferber 1991 8 p Presented at the 1991 Society for Experimental Mechanics Spring Conference, Milwaukee, 9-13 Jun. 1991
(Contract DE-AC05-84OR-21400)
(DE91-010130; CONF-9106131-2) Avail: NTIS HC/MF A02

Displacement-controlled, load-relaxation tests were evaluated for aluminum oxide and silicon nitride tensile specimens in the temperature range of 1000 to 1260 C as part of a preliminary investigation of the use of these tests for the determination of elevated temperature creep parameters. A phenomenological theory of plastic deformation was applied to the empirical results in order to characterize the deformation state of the material in terms of a mechanical equation of state using the state variable, 'plastic hardness.' Elevated temperature creep parameters determined from single specimen tests and the state variable approach were compared with the same creep parameters determined from multiple specimen tests and conventional analysis approaches. The state variable approach offers the potential of mechanistically characterizing the elevated temperature deformation using fewer specimens over shorter test times. DOE

N91-25290# Argonne National Lab., IL.
RESIDUAL STRESS CALCULATIONS IN WHISKER-REINFORCED CERAMIC MATRIX COMPOSITES
Zhuang Li and R. C. Bradt (Nevada Univ., Reno.) Feb. 1991 26 p Presented at the Conference on the Practical Applications of Residual Stress Technology, Indianapolis, 15-17 May 1991
(Contract W-31-109-eng-38)
(DE91-011163; ANL/CP-72402; CONF-910591-1) Avail: NTIS HC/MF A03

By using a modified Eshelby method, the residual stresses in SiC whisker/alumina matrix and sapphire whisker/mullite matrix composites have been calculated. The results indicate that significant residual stresses are present and are in good agreement with independent experimental measurements. Four factors are observed to influence the magnitudes and distributions of the residual stresses in these multiphase composites. They are: (1) the thermal expansion mismatch, (Delta)(alpha), (2) the elastic modulus mismatch, (Delta)E, (3) the geometry, (L/d) ratio, of the reinforcing phase, and (4) the concentration or volume fraction of the reinforcing phase. DOE

N91-25291# Midwest Research Inst., Golden, CO.
POLYMERS AS ADVANCED MATERIALS FOR DESICCANT APPLICATIONS
A. W. Czanderna Dec. 1990 88 p
(Contract DE-AC02-83CH-10093)
(DE90-000389; SERI/TP-213-3608) Avail: NTIS HC/MF A05

This research is concerned with solid materials used as desiccants for desiccant cooling systems (DCS's) that process water vapor in an atmosphere to produce cooling. Background information includes an introduction to DCS's and the role of the desiccant as a system component. The water vapor sorption performance criteria used for screening the modified polymers prepared include the water sorption capacity from 5 to 80 percent relative humidity, isotherm shape, and rate of adsorption and desorption. Measurements are presented for the sorption performance of modified polymeric advanced desiccant materials with the quartz crystal microbalance. Isotherms of polystyrene sulfonic acid (PSSA) taken over a 5-month period show that the material has a dramatic loss in capacity and that the isotherm shape is time dependent. The adsorption and desorption kinetics for PSSA and all the ionic salts of it studied are easily fast enough for commercial DCS applications with a wheel rotation speed of 6 min per revolution. Future activities for the project are addressed, and a 5-year summary of the project is included. DOE

N91-25292# Argonne National Lab., IL.
NUCLEAR MAGNETIC RESONANCE IMAGING OF GREEN-STATE CERAMICS
N. Gopalsami, S. L. Dieckman, W. A. Ellingson, R. E. Botto, P. S. Wong, H. C. Yeh, and J. P. Pollinger (Allied-Signal Aerospace Co., Torrance, CA.) Aug. 1990 39 p
(Contract W-31-109-eng-38)
(DE91-010750; ANL-90/27) Avail: NTIS HC/MF A03

Proton H-1 nuclear magnetic resonance (NMR) imaging techniques are investigated as a means to nondestructively characterize green-state (unfired) Si3N4 ceramic components. Spectroscopic results indicate that the organic additives used in the injection molding of ceramics behave as soft solids, with broad spectral peak widths (T(sub 2) less than 0.5 ms) and moderate multicomponent spin-lattice relaxation rates (T(sub 1) ranging from 11 ms to 1 s). Because of the intrinsically different spectral characteristics of the organic additives, conventional-solution NMR imaging techniques cannot be applied to these materials. Hence, the authors developed specialized NMR imaging accessories capable of applying high magnetic field gradients in a back-projection protocol. NMR images were acquired of injection-molded test bars that had been fabricated with different mixing and molding parameters. Organic concentrations determined from the NMR images were correlated with results obtained through destructive testing. The correlation suggests that NMR imaging is a viable technique for quantifying organics in injection-molded green-state ceramics. DOE

N91-25293# Argonne National Lab., IL.
APPLICATIONS OF NEUTRON REFLECTIVITY: POLYMERS AND MAGNETISM
G. P. Felcher Jan. 1991 31 p Presented at the 114th Enrico Fermi School of Physics, La Specia (Italy), 19-29 Jun. 1990
(Contract W-31-109-eng-38)
(DE91-010759; ANL/CP-72262; CONF-9006235-3) Avail: NTIS HC/MF A03

During the past decade interest in the properties of surfaces and interfaces has grown at an outstanding rate. Thin films have a common planar geometry, and the physical information most often sought is how the chemical composition and the magnetization of the film varies along its thickness. Since slow neutrons are not absorbed by most substances, they penetrate over thicknesses of some centimeters of matter before being reflected by deep interfaces as those at a liquid/solid boundary. Actually this property makes neutron reflectivity an attractive probe. The author discusses the physical quantities that are obtained by neutron reflectivity and their significance in the context of studies of polymers and magnetism. For polymers, neutron reflection allows one to delve deep in the detailed microscopic behavior of blends at each point of the phase diagram. Some of the problems presently being pursued are discussed. In the study of magnetism of thin films neutron reflection plays a role, because it is capable of giving the absolute value of the local magnetization. DOE

N91-25294# Argonne National Lab., IL.
MECHANISTIC INTERPRETATION OF GLASS REACTION: INPUT TO KINETIC MODEL DEVELOPMENT
J. K. Bates, W. L. Ebert, J. P. Bradley, and W. L. Bourcier (Lawrence

Livermore National Lab., CA.) 1991 8 p Presented at the 2nd Annual American Nuclear Society (ANS) International High Level Radioactive Waste Management Conference, Las Vegas, 28 Apr. - 3 May 1991
(Contract W-31-109-eng-38)
(DE91-010794; ANL/CP-71299; CONF-910435-67) Avail: NTIS HC/MF A02

Actinide-doped SRL 165 type glass was reacted in J-13 groundwater at 90 C for times up to 278 days. The reaction was characterized by both solution and solid analyses. The glass was seen to react nonstoichiometrically with preferred leaching of alkali metals and boron. High resolution electron microscopy revealed the formation of a complex layer structure which became separated from the underlying glass as the reaction progressed. The formation of the layer and its effect on continued glass reaction are discussed with respect to the current model for glass reaction used in the EQ3/6 computer simulation. It is concluded that the layer formed after 278 days is not protective and may eventually become fractured and generate particulates that may be transported by liquid water. DOE

N91-25295# Sandia National Labs., Albuquerque, NM.
INTERFACIAL DEBONDING IN STAINLESS STEEL/GLASS-CERAMIC SEALS
G. A. Knorovsky, R. K. Brow, R. D. Watkins, and R. E. Loehman 1990 10 p Presented at the Fall Meeting of the Minerals, Metals and Materials Society (TMS) on Physical Metallurgy and Materials in Conjunction With Materials Week and the Material Applications and Services Exposition, Detroit, 7-11 Oct. 1990
(Contract DE-AC04-76DP-00789)
(DE91-011326; SAND-89-1866C; CONF-901008-12) Avail: NTIS HC/MF A02

Advanced pyrotechnic and electronic components can be fabricated from Ni-based superalloys with hermetic seals to matched thermal expansion coefficient lithium-silicate glass ceramics (LSGC). Prior studies have characterized the interfacial reactions in these systems necessary for good chemical bonding. Similar interfacial reactions occur when LSGCs are bonded to 300-series stainless steel except that these seals debond on cooling to room temperature. We have found that Cr-depletion (from approximately 18 wt percent to approximately 5 wt percent) from the steel causes an fcc-to-bcc phase transition that expands the interfacial grains and decreases their thermal expansion coefficient, putting the LSGC into tension, causing the seal to fail. Linear elastic finite element calculations performed on a microcomputer suggest that the volume expansion associated with the phase transformation has a predominant effect compared with the difference in expansion coefficients. DOE

N91-25296* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ARC-TEXTURED HIGH EMITTANCE RADIATOR SURFACES Patent
Bruce A. Banks, inventor (to NASA) 30 Apr. 1991 6 p Filed 18 Jul. 1989 Supersedes N89-28651 (27 - 23, p 3271)
(NASA-Case-LEW-14679-1; US-Patent-5,012,062;
US-Patent-Appl-SN-381240; US-Patent-Class-219-69.11;
Int-Patent-Class-B23H-9/00) Avail: US Patent and Trademark Office CSCL 11C

High emittance radiator surfaces are produced by arc-texturing. This process produces such a surface on a metal by scanning it with a low voltage electric arc from a carbon electrode in an inert environment.
Official Gazette of the U.S. Patent and Trademark Office

N91-25297# National Inst. of Standards and Technology, Gaithersburg, MD. Polymers Div.
POLYMERS: TECHNICAL ACTIVITIES, 1990
L. E. Smith and B. M. Fanconi Jan. 1991 134 p
(PB91-159715; NISTIR-4396) Avail: NTIS HC/MF A07 CSCL 11C

Technical activities of the Polymer Division for FY 90 are reviewed. Included are descriptions of the six tasks of the division, project reports, publications, and other technical activities.
Author

N91-25298*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
CERAMIC COATINGS ON SMOOTH SURFACES Patent Application
R. A. Miller, inventor (to NASA), W. J. Brindley, inventor (to NASA), and C. J. Rouge, inventor (to NASA) 13 May 1991 12 p
(NASA-Case-LEW-15164-1; NAS 1.71:LEW-15164-1;
US-Patent-Appl-SN-699130) Avail: NTIS HC/MF A03 CSCL 11C

A metallic coating is plasma sprayed onto a smooth surface of a metal alloy substitute or on a bond coating. An initial thin ceramic layer is low pressure sprayed onto the smooth surface of the substrate or bond coating. Another ceramic layer is atmospheric plasma sprayed onto the initial ceramic layer. NASA

N91-25779*# Smithsonian Astrophysical Observatory, Cambridge, MA.
EFFECT OF THERMAL CYCLING ON STRESS IN METALLIC FILMS ON CERAMIC SUBSTRATES
Edward M. Mattison and Robert F. C. Vessot *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 301-306 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 11C

28 PROPELLANTS AND FUELS

Includes rocket propellants, igniters, and oxidizers; their storage and handling procedures; and aircraft fuels.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *44 Energy Production and Conversion.*

N91-25299# Iowa State Univ. of Science and Technology, Ames. Midwest Transportation Center.
EMISSION CONTROL IN DIESEL ENGINES BY ALCOHOL FUMIGATION Final Report, 1 Oct. 1989 - 30 Sep. 1990
J. H. VanGerpen and D. B. VanMeter May 1990 53 p
(Contract DOT/DTS088-G-0007)
(PB91-140335) Avail: NTIS HC/MF A04 CSCL 07D

The objective of the project was to investigate the use of alcohol fumigation to control the exhaust emissions from diesel engines. Previous testing by authors and others has shown that there is considerable potential for reduction of particulates and oxides of nitrogen using the technique. Specifically, the project was directed to address the questions of operating cost, formulation of alcohol-water mixture, and the potential for producing increases in other emissions. Based on test results, the authors determined that it is possible to reduce diesel emissions using alcohol fumigation. This is true even under transient conditions. Further testing is required to optimize the emission reduction but reductions of 12.7 percent in oxides of nitrogen and 28.3 percent in particulates have been observed. The engine used for the study was a four-stroke diesel engine that is characteristic of engines used for industrial and light truck use. It would be useful to conduct a similar study using a two-stroke engine typical of most bus engines. Although large differences from the results observed for four-stroke engines are not expected, the high scavenging air flow rates characteristic of two-stroke engines might cause higher levels of unburned hydrocarbon emissions when using alcohol fumigation.
GRA

N91-25300*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PRESSURIZATION AND EXPULSION OF CRYOGENIC LIQUIDS: GENERIC REQUIREMENTS FOR A LOW GRAVITY EXPERIMENT

Neil T. VanDresar and Robert J. Stochl Jun. 1991 10 p (NASA-TM-104417; E-6249; NAS 1.15:104417) Avail: NTIS HC/MF A02 CSCL 21I

Requirements are presented for an experiment designed to obtain data for the pressurization and expulsion of a cryogenic supply tank in a low gravity environment. These requirements are of a generic nature and applicable to any cryogenic fluid of interest, condensible or non-condensible pressurants, and various low gravity test platforms such as the Space Shuttle or a free-flyer. Background information, the thermophysical process, preliminary analytical modeling, and experimental requirements are discussed. Key parameters, measurements, hardware requirements, procedures, a test matrix, and data analysis are outlined. Author

N91-25204*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
PROOF-OF-CONCEPT AUTOMATION OF PROPELLANT PROCESSING
Kumar Ramohalli and P. A. Schallhorn *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 10 p (For primary document see N91-25203 17-25)
Avail: NTIS HC/MF A08 CSCL 22I

N91-25212*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
UNCONVENTIONAL PROPELLANT PERFORMANCE Abstract Only
Kumar Ramohalli and Mario Rascon *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 2 p (For primary document see N91-25203 17-25)
Avail: NTIS HC/MF A08 CSCL 21I

N91-25215*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
QUANTITATIVE COMPUTER SIMULATIONS OF EXTRATERRESTRIAL PROCESSING OPERATIONS
T. L. Vincent and P. E. Nikravesh *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 3 p (For primary document see N91-25203 17-25)
Avail: NTIS HC/MF A08 CSCL 21I

N91-25219*# Arizona Univ., Tucson.
AN ANNOTATED BIBLIOGRAPHY OF PROPELLANT PROCESSING METHODS
A. H. Cutler *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 5 p (For primary document see N91-25203 17-25)
Avail: NTIS HC/MF A08 CSCL 21I

N91-25224*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
PERFORMANCE OF UNCONVENTIONAL PROPELLANTS
Mario Rascon *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 3 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 21I

N91-25226*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
AUTONOMOUS PRODUCTION OF PROPELLANTS
Kumar Ramohalli and P. A. Schallhorn *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 3 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 21I

N91-25231*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
QUANTITATIVE COMPUTER REPRESENTATION OF PROPELLANT PROCESSING
M. D. Hicks and P. E. Nikravesh *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 7 p Original contains color illustrations (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 21I

N91-25232*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
TEMPERATURE AUTOMATION FOR A PROPELLANT MIXER
T. L. Vincent and R. G. Wilson *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 4 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 21I

N91-26080*# Rockwell International Corp., Downey, CA. Space Systems Div.
MISSION AND TRANSPORTATION SYSTEMS USES OF IN-SITU DERIVED PROPELLANTS Abstract Only
Ed Repic *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 34 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 22I

29 MATERIALS PROCESSING

Includes space-based development of products and processes for commercial applications.

For biological materials see *55 Space Biology.*

N91-25301 Case Western Reserve Univ., Cleveland, OH.
A NUMERICAL STUDY OF FLOATING ZONE CRYSTAL GROWTH UNDER MICROGRAVITY Ph.D. Thesis
Jingwen Zheng 1990 160 p
Avail: Univ. Microfilms Order No. DA9110783

A numerical scheme for floating zone crystal growth under microgravity is developed which integrates the heating, the transport phenomena in the melt and solids, and the interfaces in the growth system. The thermocapillary flow in the melt is simulated. The interface shapes and positions are determined as part of the numerical solutions. The effects of operating conditions and material properties are investigated. The importance of applied thermal signatures is demonstrated. The results from the convection dominant cases (Ma much greater than 1) are compared with those from the conduction dominant cases (Ma much less than 1). A body-fitted curvilinear coordinate system is applied to accommodate the curved moving interfaces. The finite difference method is employed to discretize the analytical equations and numerical solutions are obtained using SOR-Newton iteration method. The calculation is performed for floating zone growth of CdTe which has important applications to radiation detectors and infrared sensors and is difficult to grow on the ground.

Dissert. Abstr.

31 ENGINEERING (GENERAL)

Includes vacuum technology; control engineering; display engineering; cryogenics; and fire prevention.

N91-25302# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Structures and Materials Panel.
AGARD HANDBOOK ON ADVANCED CASTING
Dietmar Mietrach, ed. (Messerschmitt-Boelkow-Blohm G.m.b.H., Bremen, Germany, F.R.) Mar. 1991 192 p
(AGARD-AG-299; ISBN-92-835-0455-0) Copyright Avail: NTIS HC/MF A09; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The need to improve aircraft performance and, simultaneously, to reduce costs has led to a re-examination of the use of casting processes in aircraft manufacture. The Structures and Materials Panel of AGARD has provided practical information about design, mechanical values, applications, quality assurance and damage tolerance. By providing the data in this form it is hoped that the

designer will be encouraged to exploit the many recent advances in casting to optimum effect. Author

N91-25303*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
METHODS OF APPLIED DYNAMICS
M. H. Rheinfurth and H. B. Wilson (Alabama Univ., Tuscaloosa.) Washington May 1991 210 p
(NASA-RP-1262; M-659; NAS 1.61:1262) Avail: NTIS HC/MF A10 CSCL 13I

The monograph was prepared to give the practicing engineer a clear understanding of dynamics with special consideration given to the dynamic analysis of aerospace systems. It is conceived to be both a desk-top reference and a refresher for aerospace engineers in government and industry. It could also be used as a supplement to standard texts for in-house training courses on the subject. Beginning with the basic concepts of kinematics and dynamics, the discussion proceeds to treat the dynamics of a system of particles. Both classical and modern formulations of the Lagrange equations, including constraints, are discussed and applied to the dynamic modeling of aerospace structures using the modal synthesis technique. Author

N91-25304*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
COMPUTATIONAL NEEDS SURVEY OF NASA AUTOMATION AND ROBOTICS MISSIONS. VOLUME 2: APPENDIXES
Gloria J. Davis May 1991 81 p
(NASA-TM-103860-Vol-2; A-91093; NAS 1.15:103860-Vol-2)
Avail: NTIS HC/MF A05 CSCL 13B

NASA's operational use of advanced processor technology in space systems lags behind its commercial development by more than eight years. One of the factors contributing to this is the fact that mission computing requirements are frequency unknown, unstated, misrepresented, or simply not available in a timely manner. NASA must provide clear common requirements to make better use of available technology, to cut development lead time on deployable architectures, and to increase the utilization of new technology. Here, NASA, industry and academic communities are provided with a preliminary set of advanced mission computational processing requirements of automation and robotics (A and R) systems. The results were obtained in an assessment of the computational needs of current projects throughout NASA. The high percent of responses indicated a general need for enhanced computational capabilities beyond the currently available 80386 and 68020 processor technology. Because of the need for faster processors and more memory, 90 percent of the polled automation projects have reduced or will reduce the scope of their implemented capabilities. The requirements are presented with respect to their targeted environment, identifying the applications required, system performance levels necessary to support them, and the degree to which they are met with typical programmatic constraints. Here, appendixes are provided. Author

N91-25305* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
DUAL DIAPHRAGM TANK WITH TELLTALE DRAIN Patent
Wallace C. Tuthill, Jr., inventor (to NASA) 2 Jul. 1991 8 p Filed 25 Oct. 1990 Supersedes N91-13580 (29 - 5, p 645)
(NASA-Case-MSC-21703-1; US-Patent-5,027,860;
US-Patent-Appl-SN-603052; US-Patent-Class-138-30;
US-Patent-Class-138-26; Int-Patent-Class-F16L-55/04) Avail: US Patent and Trademark Office CSCL 13B

A fluid storage and expulsion system comprising a tank with an internal flexible diaphragm assembly of dual diaphragms in back-to-back relationship, at least one of which is provided with a patterned surface having fine edges such that the diaphragms are in contact along said edges without mating contact of surface areas to thereby form fluid channels which extend outwardly to the peripheral edges of the diaphragms is described. The interior wall of the tank at the juncture of tank sections is formed with a circumferential annular recess comprising an outer annular recess portion which forms a fluid collection chamber and an inner annular recess portion which accommodates the peripheral edge portions of the diaphragms and a sealing ring in clamped sealing relation therebetween. The sealing ring is perforated with radially extending passages which allow any fluid leaking or diffusing past a diaphragm to flow through the fluid channels between the diaphragms to the fluid collection chamber. Ports connectable to pressure fittings are provided in the tank sections for admission of fluids to opposite sides of the diaphragm assembly. A drain passage through the tank wall to the fluid collection chamber permits detection, analysis and removal of fluids in the collection chamber.
Official Gazette of the U.S. Patent and Trademark Office

N91-25306*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
APPARATUS FOR JOINING TRUSSES Patent Application
Jeffrey Finckenor, inventor (to NASA) 25 Mar. 1991 11 p
(NASA-Case-MFS-28545-1; NAS 1.71:MFS-28545-1;
US-Patent-Appl-SN-674636) Avail: NTIS HC/MF A03 CSCL 13B

This invention relates to a joint for holding a pair of trusses together in axial alignment. The joint includes a pair of cylindrical locking elements secured to the ends of the trusses. The locking elements each having a plurality of lands and grooves which lie in parallel planes when the trusses are in axial alignment. A pair of clamps positioned on opposite sides of the trusses are provided with a plurality of lands and grooves which mesh with the lands and grooves on the locking elements, with means being provided for urging the clamps toward each other to bring the trusses into axial alignment and hold them in that position. NASA

N91-25238*# Arizona Univ., Tucson. Dept. of Civil Engineering and Engineering Mechanics.
DEVELOPMENT AND MECHANICAL PROPERTIES OF CONSTRUCTION MATERIALS FROM LUNAR SIMULANTS
Chandra S. Desai *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 4 p
(For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 13B

32 COMMUNICATIONS AND RADAR

Includes radar; land and global communications; communications theory; and optical communications.

For related information see also *04 Aircraft Communications and Navigation* and *17 Space Communications, Spacecraft Communications, Command and Tracking.* For search and rescue see *03 Air Transportation and Safety,* and *16 Space Transportation.*

N91-25307 Rhode Island Univ., Kingston.
AN EXPERIMENTAL AND NUMERICAL STUDY OF THE EFFECT OF MICROSTRUCTURE ON WAVE PROPAGATION PHENOMENA IN GRANULAR MEDIA Ph.D. Thesis
Changyi Zhu 1990 182 p
Avail: Univ. Microfilms Order No. DA9109485

An experimental and numerical investigation was conducted to study wave propagation in granular materials with microstructure. An attempt was made to look at the effect of microstructure, contact angle, inclusions, and voids as well as preloading on wave phenomena in these materials. The granular media were simulated by birefringent brittle polyester Homalite-100 circular disks. A small amount of explosive was used to generate the dynamic loading. Granular aggregate chains were used to look at the dependence of dynamic load transfer on particle contact angles. Systematic as well as irregular packing geometrics were employed to investigate the effect of granular microstructure on wave velocity and attenuation. Inclusions and voids were created in a hexagonal closed packing granular assembly to study the local effect of these discontinuities on wave behavior. An effort was also made to explore the wave propagation phenomena in a body centered cubic packing geometry under biaxial loading condition. Dynamic photoelasticity in conjunction with high speed photography were

used to collect the necessary data associated with the propagating waves in model granules. These data were analyzed to obtain the interparticle dynamic loads, envelope of the load transfer, wave velocity, and wave attenuation. Based on the experimental work, a numerical scheme based on the principle of superposition was proposed to characterize the dynamic load transfer in these model materials. Finally, a plane wave generator was designed and built for the purpose of studying the behavior of granular media under plane stress wave loading condition. Dissert. Abstr.

N91-25308 Rice Univ., Houston, TX.
GEOMETRIC NONLINEAR FILTERING THEORY WITH APPLICATION TO THE MANEUVERING AIRCRAFT TRACKING PROBLEM Ph.D. Thesis
Robert H. Bishop 1990 174 p
Avail: Univ. Microfilms Order No. DA9110948

A geometric nonlinear filter (GNF) is designed for application to the problem of tracking a maneuvering aircraft. The aircraft tracking problem is a state estimation problem and a state prediction problem. A nonlinear aircraft maneuver model is proposed for use in the state estimation as well as the state prediction. This nonlinear model based on so-called coordinated turn and describes planar trajectories. The GNF design approach involves state transformations with output injection to transform the nonlinear system model to a linear form, known as the observer canonical form. For many nonlinear systems, such as the proposed aircraft maneuver model, this linearizing transformation does not exist. Therefore, for the maneuvering aircraft model, a transformation to an approximate observer cononical form is given. Utilizing a Lyapunov stability approach, sufficient conditions for stability of the GNF estimation error are derived. No such conditions exist for the extended Kalman filter (EKF). The GNF was found to be stable in cases where the EKF was not stable. The tracking performance of the GNF compares favorable with the EKF for various levels of measurement noise. However, the GNF offers a substantial savings in computational time making it more attractive than the EKF for use in a fire control computer. Dissert. Abstr.

N91-25309 Surrey Univ., Guildford (England).
DIGITAL SIGNAL PROCESSING TECHNIQUES FOR ON-BOARD PROCESSING SATELLITES Ph.D. Thesis
Ching Chung Kwan 1990 278 p
Avail: Univ. Microfilms Order No. BRDX91768

In on-board processing satellite systems in which frequency division multiple access (FDMA)/signal channel per carrier (SCPC) access schemes are employed, transmultiplexers are required for the frequency demultiplexing of the SCPC signals. Digital techniques for the implementation of the transmultiplexer for such application were examined. The signal processing in the transmultiplexer operations involved many parameters which could be optimized in order to reduce the hardware complexity while satisfying the level of performance required of the system. An approach for the assessment of the relationship between the various parameters and the system performance was devised, which allowed hardware requirement of practical system specifications to be estimated. For systems involving signals of different bandwidths, a more flexible implementation of the transmultiplexer is required and two computationally efficient methods, the DFT convolution and analysis/synthesis filter bank, were investigated. These methods gave greater flexibility to the input frequency plan of the transmultiplexer, at the expense of increased computational requirements. Filters were then designed to exploit specific properties of the flexible transmultiplexer methods, resulting in considerable improvement in their efficiencies. Hardware implementation of the flexible transmultiplexer was considered and an efficient multiprocesser architecture in combination with parallel processing software algorithms for the signal processing operations were designed. Finally, an experimental model of the payload for a land-mobile satellite system proposal, T-SAT, was constructed using general-purpose digital signal processors and the merits of the on-board processing architecture were demonstrated. Author

N91-25310 British Broadcasting Corp., Kingswood (England). Engineering Div.
A STUDY OF SOUND BALANCES FOR THE HARD OF HEARING
C. D. Mathers 1991 16 p
(BBC-RD-1991/3) Copyright Avail: BBC, Kingswood Warren, Tadworth, Surrey, England

Over a period of years, complaints have been received from television viewers, especially those who are hard of hearing, that background sound (e.g., audience laughter, crowd noise, mood music) is often transmitted at too high a level with respect to speech, so that information essential to the understanding of the program is lost. To consider possible solutions to the problem, a working party was set up representing both broadcasters and organizations for the hard of hearing. At early meetings, it was resolved that a series of subjective tests should be carried out to determine what reduction of background levels would be needed to provide a significant improvement in the intelligibility of television speech for viewers with hearing difficulties. The preparation of test tapes and the analysis of results are given. Author

N91-25311 British Broadcasting Corp., Kingswood (England). Engineering Div.
DIGITAL AUDIO BROADCASTING: THE FIRST UK FIELD TRIAL
P. Shelswell, C. P. Bell, J. H. Stott, S. Wakelig, M. C. D. Maddocks, J. H. Moore, P. R. Durrant, and R. F. Rudd 1991 29 p
(BBC-RD-1991/2) Copyright Avail: Issuing Activity

The BBC was offered equipment for transmission and reception of Digital Audio Broadcasting signals using COFDM (Coded Orthogonal Frequency Division Multiplex) and MASCAM (Masking-pattern Adapted Sub-band Coding and Multiplexing). Details of the trials that were carried out using a UHF frequency are presented. The conclusions are that the signal is robust in the present of echoes. As a consequence, COFDM was found to be a suitable modulation system for broadcasting high quality digital sound to the home, to mobile receivers and to portable receivers. The quality of the MASCAM sound signals was very good in the mobile environment. Author

N91-25312 British Broadcasting Corp., Kingswood (England). Engineering Div.
INTERFERENCE PROTECTION REQUIREMENTS FOR TERRESTRIAL MICROWAVE LINKS IN THE UK PRIVATE-USER FREQUENCY BANDS
P. D. Gill and M. C. D. Maddocks 1991 51 p
(BBC-RD-1991/1) Copyright Avail: Issuing Activity

Many broadcast television circuits are carried on microwave links in the private-user frequency bands. At present the television signals are carried in analogue form. High data-capacity links would be required to allow television signals to be carried in digital form. The bandwidth available in the lower frequency private-user bands (which are more desirable as they allow longer hop lengths) is limited. As a result, more sophisticated, bandwidth-efficient modulation techniques are required. Systems using more than four amplitude and phase states are not currently used in the private-user frequency bands. Before they can be introduced the protection requirements for interference to and from each of the many different analogue and digital systems used at present in these bands must be determined. Described here is a set of experimental measurements and theoretical calculations to determine the interference protection requirements of dissimilar analogue and digital systems. Recommendations are made as to the most suitable method of determining the protection ratios required for interference between systems. This approach should be used to determine the protection requirements, both for new systems and existing ones. It is also recommended that the receive filter response should be specified and checked during type-approval tests and that the transmit spectrum masks should be modified to reduce the permitted level of out-of-band radiation. Author

N91-25313# Joint Publications Research Service, Arlington, VA.
JPRS REPORT: SCIENCE AND TECHNOLOGY. CHINA: RADAR CROSS SECTION STUDIES
3 Apr. 1991 23 p Transl. into ENGLISH from various Chinese articles
(JPRS-CST-91-008) Avail: NTIS HC/MF A03

Abstracts of research in radar cross sections, target scattering, analysis of electromagnetic characteristics of a 3-D dielectric radome by complex astigmatic wave theory, and analysis of target radar cross sections by complex ray expansion are given.

Author

N91-25314# Lawrence Livermore National Lab., CA.
EVALUATION OF MODIFIED LOG-PERIODIC ANTENNAS FOR PULSE TRANSMISSION
G. J. Burke Apr. 1991 20 p
(Contract W-7405-eng-48)
(DE91-011775; UCRL-ID-106868) Avail: NTIS HC/MF A03

The log-periodic dipole (LPD) antenna can operate over a very wide frequency band, limited only by mechanical constraints. However, the antenna is known to introduce significant distortion when radiating a transient signal, due to its nonlinear phase versus frequency response. A modified design has been proposed by Yatskevich and Fedosenko to reduce distortion of a pulse by making the phase response linear or, more generally, to develop a filter characteristic for compressing a signal such as a linear FM pulse. Some results from numerical modeling of these linear-phase and FM-compression antennas are presented here to evaluate their effectiveness. DOE

N91-25315# EG and G Energy Measurements, Inc., Los Alamos, NM.
IS CEPSTRUM AVERAGING APPLICABLE TO CIRCULARLY POLARIZED ELECTRIC-FIELD DATA?
T. Tunnell 25 Apr. 1990 8 p
(Contract DE-AC08-88NV-10617)
(DE91-010824; EGG-10617-5069; LAO-2732-1946) Avail: NTIS HC/MF A02

In FY 1988 a cepstrum averaging technique was developed to eliminate the ground reflections from charged particle beam (CPB) electromagnetic pulse (EMP) data. The work was done for the Los Alamos National Laboratory Project DEWPOINT at SST-7. The technique averages the cepstra of horizontally and vertically polarized electric field data (i.e., linearly polarized electric field data). This cepstrum averaging technique was programmed into the FORTRAN codes CEP and CEPSIM. Steve Knox, the principal investigator for Project DEWPOINT, asked the authors to determine if the cepstrum averaging technique could be applied to circularly polarized electric field data. The answer is, Yes, but some modifications may be necessary. There are two aspects to this answer that we need to address, namely, the Yes and the modifications. First, regarding the Yes, the technique is applicable to elliptically polarized electric field data in general: circular polarization is a special case of elliptical polarization. Secondly, regarding the modifications, greater care may be required in computing the phase in the calculation of the complex logarithm. The calculation of the complex logarithm is the most critical step in cepstrum-based analysis. This memorandum documents these findings. DOE

N91-25316* National Aeronautics and Space Administration. Pasadena Office, CA.
DOPPLER-CORRECTED DIFFERENTIAL DETECTION SYSTEM Patent
Marvin K. Simon, inventor (to NASA) and Dariush Divsalar, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 9 Apr. 1991 27 p Filed 7 Jun. 1988 Supersedes N88-30001 (26 - 24, p 3359)
(Contract NAS7-918)
(NASA-Case-NPO-16987-1-CU; US-Patent-5,007,068;
US-Patent-Appl-SN-203374; US-Patent-Class-375-53;
US-Patent-Class-375-56; US-Patent-Class-375-85;
US-Patent-Class-375-97; Int-Patent-Class-H04B-1/10) Avail: US Patent and Trademark Office CSCL 17B

Doppler in a communication system operating with a multiple differential phase-shift-keyed format (MDPSK) creates an adverse phase shift in an incoming signal. An open loop frequency estimation is derived from a Doppler-contaminated incoming signal. Based upon the recognition that, whereas the change in phase of the received signal over a full symbol contains both the differentially encoded data and the Doppler induced phase shift, the same change in phase over half a symbol (within a given symbol interval) contains only the Doppler induced phase shift, and the Doppler effect can be estimated and removed from the incoming signal. Doppler correction occurs prior to the receiver's final output of decoded data. A multiphase system can operate with two samplings per symbol interval at no penalty in signal-to-noise ratio provided that an ideal low pass pre-detection filter is employed, and two samples, at 1/4 and 3/4 of the symbol interval T sub s, are taken and summed together prior to incoming signal data detection.

Official Gazette of the U.S. Patent and Trademark Office

N91-25317* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
METHOD AND APPARATUS FOR SENSOR FUSION Patent
Kumar Krishen, inventor (to NASA), Scott Shaw, inventor (to NASA), and Rui J. P. deFigueiredo, inventor (to NASA) 2 Apr. 1991 24 p Filed 30 Dec. 1988 Supersedes N89-25360 (27 - 19, p 2703)
(NASA-Case-MSC-21334-1; US-Patent-5,005,147;
US-Patent-Appl-SN-292130; US-Patent-Class-364-578;
Int-Patent-Class-G06F-15/20) Avail: US Patent and Trademark Office CSCL 17I

Method and apparatus for fusion of data from optical and radar sensors by error minimization procedure is presented. The method was applied to the problem of shape reconstruction of an unknown surface at a distance. The method involves deriving an incomplete surface model from an optical sensor. The unknown characteristics of the surface are represented by some parameter. The correct value of the parameter is computed by iteratively generating theoretical predictions of the radar cross sections (RCS) of the surface, comparing the predicted and the observed values for the RCS, and improving the surface model from results of the comparison. Theoretical RCS may be computed from the surface model in several ways. One RCS prediction technique is the method of moments. The method of moments can be applied to an unknown surface only if some shape information is available from an independent source. The optical image provides the independent information.

Official Gazette of the U.S. Patent and Trademark Office

N91-25318* National Aeronautics and Space Administration. Pasadena Office, CA.
PHASE AMBIGUITY RESOLUTION FOR OFFSET QPSK MODULATION SYSTEMS Patent
Tien M. Nguyen, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 18 Jun. 1991 18 p Filed 30 Nov. 1989 Supersedes N90-16975 (28 - 9, p 1204)
(Contract NAS7-918)
(NASA-Case-NPO-17853-1-CU; US-Patent-5,025,455;
US-Patent-Appl-SN-443539; US-Patent-Class-375-53;
US-Patent-Class-375-86; US-Patent-Class-329-304;
Int-Patent-Class-H04L-27/18) Avail: US Patent and Trademark Office CSCL 17B

A demodulator for Offset Quaternary Phase Shift Keyed (OQPSK) signals modulated with two words resolves eight possible combinations of phase ambiguity which may produce data error by first processing received I(sub R) and Q(sub R) data in an integrated carrier loop/symbol synchronizer using a digital Costas loop with matched filters for correcting four of eight possible phase lock errors, and then the remaining four using a phase ambiguity resolver which detects the words to not only reverse the received I(sub R) and Q(sub R) data channels, but to also invert (complement) the I(sub R) and/or Q(sub R) data, or to at least

complement the I(sub R) and Q(sub R) data for systems using nontransparent codes that do not have rotation direction ambiguity.

Official Gazette of the U.S. Patent and Trademark Office

N91-25761*# SEPA S.p.A., Turin (Italy).
INTER-SATELLITE TIME TRANSFER: TECHNIQUES AND APPLICATIONS
Edoardo Detoma and S. Clark Wardrip (Bendix Field Engineering Corp., Santa Maria, CA.) *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 61-86 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 17B

N91-25772*# Burkhardt Monitoring Service, Glen Allen, VA.
PRECISE FREQUENCY CALIBRATION USING TELEVISION VIDEO CARRIERS
Edward E. Burkhardt *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 231-233 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 17B

N91-25775*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
APPLICATION OF HIGH STABILITY OSCILLATORS TO RADIO SCIENCE EXPERIMENTS USING DEEP SPACE PROBES
Emil R. Kursinski *In its* The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 253-268 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 17B

N91-25789*# Nippon Telegraph and Telephone Public Corp., Yokosuka (Japan). Transmission Systems Labs.
TIME CONCURRENCY/PHASE-TIME SYNCHRONIZATION IN DIGITAL COMMUNICATIONS NETWORKS
Masami Kihara and Atsushi Imaoka *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 367-374 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 17B

N91-25790*# Cable and Wireless PLC, London (England).
THE CABLE AND WIRELESS APPROACH TO NETWORK SYNCHRONIZATION
Robert D. Calvert *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 375-382 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 17B

N91-25905# Technical Univ. of Norway, Trondheim.
BROADER COMMUNICATION BANDS
Gunnar Stette *In* AGARD, Bridging the Communication Gap Feb. 1991 10 p (For primary document see N91-25902 17-82)
Copyright Avail: NTIS HC/MF A06; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

N91-25909# Tome Associates Ltd., London (England).
THE ROLE OF INTELLIGENT ONLINE INTERFACES TO BRIDGE THE COMMUNICATION GAP
A. Vickery *In* AGARD, Bridging the Communication Gap Feb. 1991 9 p (For primary document see N91-25902 17-82)
Copyright Avail: NTIS HC/MF A06; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

33 ELECTRONICS AND ELECTRICAL ENGINEERING

Includes test equipment and maintainability; components, e.g., tunnel diodes and transistors; microminiaturization; and integrated circuitry.

For related information see also *60 Computer Operations and Hardware* and *76 Solid-State Physics.*

N91-25319*# Toledo Univ., OH. Dept. of Chemical Engineering.
THERMAL MODELING OF A NI-H2 BATTERY CELL Final Technical Report
Si-Ok Ryu, K. J. DeWitt, and T. G. Keith 1991 32 p
(Contract NCC3-69)
(NASA-CR-188538; NAS 1.26:188538) Avail: NTIS HC/MF A03 CSCL 09A

The nickel-hydrogen secondary battery has many desirable features which make it attractive for satellite power systems. It can provide a significant improvement over the energy density of present spacecraft nickel-cadnium batteries, combined with longer life, tolerance to overcharge and possibility of state-of-charge indication. However, to realize these advantages, accurate thermal modeling of nickel-hydrogen cells is required in order to properly design the battery pack so that it operates within a specified temperature range during the operation. Maintenance of a low operating temperature and a uniform temperature profile within the cell will yield better reliability, improved cycle life and better charge/discharge efficiencies. This research has the objective of developing and testing a thermal model which can be used to characterize battery operation. Primarily, temperature distribution with the heat generation rates as a function of position and time will be evaluated for a Ni-H2 cell in the three operating modes: (1) charge cycle, (2) discharge cycle, and (3) overcharge condition, if applicable. Variables to be examined include charging current, discharge rates, state of charge, pressure and temperature. Once the thermal model has been developed, this resulting model will predict the actual operating temperature and temperature gradient for the specific cell geometry to be used. Author

N91-25320*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
COMPARATIVE STUDY OF BOLOMETRIC AND NON-BOLOMETRIC SWITCHING ELEMENTS FOR MICROWAVE PHASE SHIFTERS
Massood Tabib-Azar (Case Western Reserve Univ., Cleveland, OH.), Kul B. Bhasin, and Robert R. Romanofsky 1991 12 p Presented at the Optical Engineering and Photonics in Aerospace Sensing Symposium, Orlando, FL, 1-5 Apr. 1991; sponsored by the International Society for Optical Engineers
(Contract NCC3-203; RC-471035)
(NASA-TM-104435; E-6273; NAS 1.15:104435) Avail: NTIS HC/MF A03 CSCL 09A

The performance of semiconductor and high critical temperature superconductor switches is compared as they are used in delay-line-type microwave and millimeter-wave phase shifters. Such factors as their ratios of the off-to-on resistances, parasitic reactances, power consumption, speed, input-to-output isolation, ease of fabrication, and physical dimensions are compared. Owing to their almost infinite off-to-on resistance ratio and excellent input-to-output isolation, bolometric superconducting switches appear to be quite suitable for use in microwave phase shifters; their only drawbacks are their speed and size. The SUPERFET, a novel device whose operation is based on the electric field effect in high critical temperature ceramic superconductors is also discussed. Preliminary results indicate that the SUPERFET is fast and that it can be scaled; therefore, it can be fabricated with dimensions comparable to semiconductor field-effect transistors. Author

N91-25321*# Wisconsin Univ., Madison. Dept. of Electrical and Computer Engineering.

HIGH POWER DENSITY dc-TO-dc CONVERTERS FOR AEROSPACE APPLICATIONS Final Report, Jul. 1989 - Dec. 1990

Deepakraj M. Divan Dec. 1990 337 p
(Grant NAG3-804)
(NASA-CR-188611; NAS 1.26:188611) Avail: NTIS HC/MF A15 CSCL 09C

Three dc-to-dc converter topologies aimed at high-power high-frequency applications are introduced. Major system parasitics, namely, the leakage inductance of the transformer and the device output capacitance are efficiently utilized. Of the three circuits, the single-phase and three-phase versions of the dual active bridge topology demonstrate minimal stresses, better utilization of the transformer, bidirectional, and buck-boost modes of operation. All circuits operate at a constant switching frequency, thus simplifying design of the reactive elements. The power transfer characteristics and soft-switching regions on the Vout-Iout plane are identified. Two coaxial transformers with different cross-sections were built for a rating of 50 kVA. Based on the single-phase dual active bridge topology, a 50 kW, 50 kHz converter operating at an input voltage of 200 Vdc and an output voltage of 1600 Vdc was fabricated. Characteristics of current-fed output make the dual active bridge topologies amenable to paralleling and hence extension to megawatt power levels. Projections to a 1 MW system operating from a 500 Vdc input, at an output voltage of 10 kVdc and a switching frequency of 50 kHz, using MOS-controlled thyristors, coaxially wound transformers operating at three times the present current density with cooling, and multilayer ceramic capacitors, suggests an overall power density of 0.075 to 0.08 kg/kW and an overall efficiency of 96 percent. Author

N91-25322*# Colorado State Univ., Fort Collins. Dept. of Chemistry.

NEW SECONDARY BATTERIES USING ELECTRONICALLY CONDUCTIVE POLYMER CATHODES Final Report, 1 Jan. 1989 - 30 Jun. 1991

Charles R. Martin and Ralph E. White (Texas A&M Univ., College Station.) May 1991 315 p
(Grant NAG9-173)
(NASA-CR-188604; NAS 1.26:188604) Avail: NTIS HC/MF A14 CSCL 09C

A Li/Polypyrrole secondary battery was designed and built, and the effect of controlling the morphology of the polymer on enhancement of counterion diffusion in the polymer phase was explored. The experimental work was done at Colorado State University, while the mathematical modeling of the battery was done at Texas A and M University. Manuscripts and publications resulting from the project are listed. For individual titles, see N91-25323 through N91-25324.

N91-25323*# Texas A&M Univ., College Station.

EFFECT OF POLYMER ELECTRODE MORPHOLOGY ON PERFORMANCE OF A LITHIUM/POLYPYRROLE BATTERY M.S. Thesis

Marjorie Anne Nicholson *In* Colorado State Univ., New Secondary Batteries Using Electronically Conductive Polymer Cathodes May 1991 125 p (For primary document see N91-25322 17-33)
Avail: NTIS HC/MF A14 CSCL 09C

A variety of conducting polymer batteries were described in the recent literature. In this work, a Li/Polypyrrole secondary battery is described. The effect of controlling the morphology of the polymer on enhancement of counterion diffusion in the polymer phase is explored. A method of preparing conducting polymers was developed which yields high surface area per unit volume of electrode material. A porous membrane is used as a template in which to electrochemically polymerize pyrrole, then the membrane is dissolved, leaving the polymer in a fibrillar form. Conventionally, the polymer is electrochemically polymerized as a dense polymer film on a smooth Pt disk electrode. Previous work has shown that when the polymer is electrochemically polymerized in fribrillar form, charge transport rates are faster and charge capacities are greater than for dense, conventionally grown films containing the same amount of polymer. The purpose is to expand previous work by further investigating the possibilities of the optimization of transport rates in polypyrrole films by controlling the morphology of the films. The utility of fibrillar polypyrrole as a cathode material in a lithium/polymer secondary battery is then assessed. The performance of the fibrillar battery is compared to the performance of an analogous battery which employed a conventionally grown polypyrrole film. The study includes a comparison of cyclic voltammetry, shape of charge/discharge curves, discharge time and voltage, cycle life, coulombic efficiencies, charge capacities, energy densities, and energy efficiencies. Author

N91-25324*# Texas A&M Univ., College Station.

NEW SECONDARY BATTERIES UTILIZING ELECTRONICALLY CONDUCTIVE POLYPYRROLE CATHODE Ph.D. Thesis

Taewhan Yeu *In* Colorado State Univ., New Secondary Batteries Using Electronically Conductive Polymer Cathodes May 1991 159 p (For primary document see N91-25322 17-33)
Avail: NTIS HC/MF A14 CSCL 09C

To gain a better understanding of the dynamic behavior in electronically conducting polypyrroles and to provide guidance toward designs of new secondary batteries based on these polymers, two mathematical models are developed; one for the potentiostatically controlled switching behavior of polypyrrole film, and one for the galvanostatically controlled charge/discharge behavior of lithium/polypyrrole secondary battery cell. The first model is used to predict the profiles of electrolyte concentrations, charge states, and electrochemical potentials within the thin polypyrrole film during switching process as functions of applied potential and position. Thus, the detailed mechanisms of charge transport and electrochemical reaction can be understood. Sensitivity analysis is performed for independent parameters, describing the physical and electrochemical characteristic of polypyrrole film, to verify their influences on the model performance. The values of independent parameters are estimated by comparing model predictions with experimental data obtained from identical conditions. The second model is used to predict the profiles of electrolyte concentrations, charge state, and electrochemical potentials within the battery system during charge and discharge processes as functions of time and position. Energy and power densities are estimated from model predictions and compared with existing battery systems. The independent design criteria on the charge and discharge performance of the cell are provided by studying the effects of design parameters. Author

N91-25325# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.

UPPER AND LOWER BOUNDS ON SWITCHING ENERGY IN VLSI

Gloria Kissin (Amsterdam Univ., Netherlands) Sep. 1990 38 p Submitted for publication Sponsored by Netherlands Organization for the Advancement of Research
(CWI-CS-R9044; ETN-91-99374) Copyright Avail: NTIS HC/MF A03

A technology independent framework is established for measuring the 'switching energy' consumed by Very Large Scale Integrated (VLSI) circuits. Techniques are developed for analyzing functional energy consumption, and for designing energy efficient VLSI circuits. A wire (or gate) in a circuit uses switching energy when it changes state from 1 to 0 or vice versa. The 'Uniswitch Model' (USM) of energy consumption, which measures the differences between pairs of states of an embedded circuit, is developed. The following worst case lower bounds are obtained in USM. Monotone circuits require switching energy proportional to the circuit's area. A class of n-input, boolean valued functions, including addition and multiplication, uses Omega (n log(2)n) switching energy, when computed by a shallow depth circuit. A special case of the parity function is shown to require switching energy proportional to the area. Upper bounds in USM are derived. Novel circuits and layouts are obtained for n-bit OR and compare functions that have shallow depth and use only linear energy, in

the worst case. A shallow depth n-bit addition circuit is laid out in a manner that uses linear energy, on the average. This is a log factor better than the worst case lower bound for addition. ESA

N91-25326# Technische Univ., Delft (Netherlands).
DESIGN AND IMPLEMENTATION OF HIGHLY PARALLEL PIPELINED VLSI SYSTEMS Ph.D. Thesis
Alphonsus Anthonius deLange 1991 185 p
(ETN-91-99432) Avail: NTIS HC/MF A09

A methodology and its realization as a prototype CAD (Computer Aided Design) system for the design and analysis of complex multiprocessor systems is presented. The design is an iterative process in which the behavioral specifications of the system components are refined into structural descriptions consisting of interconnections and lower level components etc. A model for the representation and analysis of multiprocessor systems at several levels of abstraction and an implementation of a CAD system based on this model are described. A high level design language, an object oriented development kit for tool design, a design data management system, and design and analysis tools such as a high level simulator and graphics design interface which are integrated into the prototype system and graphics interface are described. Procedures for the synthesis of semiregular processor arrays, and to compute the switching of input/output signals, memory management and control of processor array, and sequencing and segmentation of input/output data streams due to partitioning and clustering of the processor array during the subsequent synthesis steps, are described. The architecture and control of a parallel system is designed and each component mapped to a module or module generator in a symbolic layout library, compacted for design rules of VLSI (Very Large Scale Integration) technology. An example of the design of a processor that is a useful building block for highly parallel pipelined systems in the signal/image processing domains is given. ESA

N91-25327# California Univ., Berkeley. Lawrence Berkeley Lab.
ELECTROCATALYSTS FOR OXYGEN ELECTRODES
E. Yeager (Case Western Reserve Univ., Cleveland, OH.) Oct. 1990 63 p
(Contract DE-AC03-76SF-00098)
(DE91-010226; LBL-29696) Avail: NTIS HC/MF A04

The overall objective of this research was an in-depth understanding of the factors controlling O2 reduction and generation on various electrocatalysts and the use of this understanding to identify much higher activity, stable catalysts. The following is a brief summary of the research for the period 1 April 1989 to 31 March 1990. (1) Transition metal monomeric and sheet-polymeric macrocycle catalysts -- The iron tetrasulfonated phthalocyanine (FeTsPc) complex adsorbed on an electrode surface has high activity for the 4-electron reduction of O2 to water or OH(exp -) in alkaline solutions. (2) Polymer-modified electrodes -- Poly(4-vinyl pyridine) (PVP)-modified electrodes with adsorbed CoTsPc exhibited much higher catalytic activity for O2 reduction than the electrode with only adsorbed CoTsPc in acid solutions. (3) Transition metal oxide catalysts and bifunctional electrodes -- Anion-exchange membranes were found to greatly improve the performance of the pyrochlore-based bifunctional oxygen electrodes when operating in the O2 generation mode. (4) Catalyst supports -- The use of mildly fluorinated carbon blacks as catalyst supports for platinum was explored in cooperation with the Electrosynthesis Company (ESC). DOE

N91-25328# Johnson Controls, Inc., Milwaukee, WI.
RESEARCH AND DEVELOPMENT OF ADVANCED LEAD-ACID BATTERIES FOR ELECTRIC VEHICLE PROPULSION
19 Sep. 1990 46 p
(Contract DE-AC02-86NV-10509)
(DE91-010483; DOE/CH-10509/01) Avail: NTIS HC/MF A03

The U.S. Department of Energy sponsors a number of research and development activities that have a common goal, the demonstration of advanced batteries that meet the energy, power, and life requirements needed to make electric vehicles a viable alternative to fuel-powered vehicles. An advanced lead-acid battery is one of the technologies being pursued for near-term applications. To this end, Johnson Controls, Inc. (JCI) began work in December 1985 on a new cell concept based on continuous electrolyte recirculation to boost the level of performance beyond the capabilities of conventional lead-acid technology. Superior levels of power and energy were demonstrated for both the flow-through and the more recent flow-by cell designs in the initial years of this program. The cycle-life of these cells, however, fell short of the target for acceptable life. This report summarizes JCI's technical efforts during the period May 1989 to May 1990. During this interval, JCI concentrated on two activities, further research to identify factors that cause and contribute to low cycle-life and continued engineering to evaluate new cell designs. DOE

N91-25329# Sandia National Labs., Albuquerque, NM.
CHARACTERIZATION OF ELECTROLYTE-BINDER MIXES FOR USE IN THERMAL BATTERIES
R. A. Guidotti and F. W. Reinhardt Mar. 1991 44 p
(Contract DE-AC04-76DP-00789)
(DE91-011267; SAND-90-2103) Avail: NTIS HC/MF A03

A number of metal oxides were evaluated for their ability to immobilize molten LiCl-KCl eutectic in electrolyte-binder (EB) mixes used in thermally activated batteries. These metal oxides included fumed silicas, alumina, and a titania (all prepared by steam hydrolysis of the halides), floated silicas, MgO, and an alumina molecular sieve. The characteristics of the EB powders that were used as metrics were flow properties, homogeneity, BET surface area, particle-size distribution, and moisture content. The characteristics of EB pellets used as metrics were deformation at 530 C under an applied pressure and tendency for electrolyte leakage at 400 C. Many of the same characterization techniques used for EB powders were applied to the LiCl-KCl eutectic, its component halides, and the metal oxides as well. The reproducibility of the properties of several of the standard Sandia EB mixes was evaluated for materials prepared at a number of thermal-battery manufacturing facilities following the same processing procedures. DOE

N91-25330# Los Alamos National Lab., NM.
PRACTICAL NOISE CONTROL IN ELECTRONIC SYSTEMS
D. W. MacArthur Apr. 1991 75 p
(Contract W-7405-eng-36)
(DE91-010947; LA-12076-MS) Avail: NTIS HC/MF A04

Electrical noise, both internally and externally generated, is a problem common to all electronics-based detection systems and control assemblies. This report attempts to explain basic noise and interference types without delving too deeply into the intricacies of noise theory. For this report, noise is defined practically as any signal that interferes with the passage of a desired signal through an assembly. In particular, interfering signals (commonly referred to as noise, drift, interference, and pickup) are discussed. Practical solutions are presented for many of the problems normally found in electronic assemblies. These problems and solutions are based upon practical experience with actual electronic circuits. No attempt has been made to exhaustively describe all types of noise that are not commonly observed. The report describes general considerations, intrinsic noise, internal noise, external noise, cables and connectors, noise solutions, grounds and grounding problems, and tests and test equipment. DOE

N91-25331# Sandia National Labs., Albuquerque, NM.
OXIDIZED POROUS SILICON MOISTURE SENSORS FOR EVALUATION OF MICROELECTRONIC PACKAGING
M. J. Kelly, T. R. Guilinger, D. W. Peterson, M. R. Tuck, and J. N. Sweet 1991 9 p Presented at the Spring Meeting of the Materials Research Society (MRS), Anaheim, 29 Apr. - 3 May 1991
(Contract DE-AC04-76DP-00789)
(DE91-011322; SAND-90-3085C; CONF-910406-1) Avail: NTIS HC/MF A02

Accurate moisture measurements in microelectronic assemblies are crucial in assessing reliability of integrated circuits (ICs). We

describe the fabrication and use of a silicon-based device for evaluation of moisture barrier coatings. The capacitive moisture sensors use oxidized porous silicon (OPS) as the sensing element. Porous silicon (PS) is formed by anodization of silicon in hydrofluoric acid (HF). Oxidation of PS in oxygen produces OPS, which is also porous if an appropriate starting microstructure and oxidation treatment are selected. Metallization layers on the OPS and the wafer back complete the capacitor structure. The capacitance of OPS sensors is functionally related to the moisture content of the surrounding atmosphere. For example, the capacitance of one sensor changed from 4 nF/sq cm when exposed to a moisture level of 300 ppm (by volume) to 36 nF/sq cm at 10,000 ppm. In addition to this excellent sensitivity, capacitor response to step changes in moisture is rapid and reversible. The sensors are also rugged, as demonstrated by their consistent performance during accelerated testing at 85 percent relative humidity and 140 C. A silicon nitride IC moisture barrier coating was deposited on sensors of this type after normal ceramic dual in-line packaging. Sensor operability after coating deposition was confirmed following intentional introduction of a pinhole into the moisture barrier coating. DOE

N91-25332# Los Alamos National Lab., NM.
HIGH-CURRENT RELATIVISTIC KLYSTRON AMPLIFIER DEVELOPMENT FOR MICROSECOND PULSE LENGTHS
M. V. Fazio, B. E. Carlsten, R. J. Faehl, T. J. Kwan, D. G. Rickel, R. M. Stringfield, and P. J. Tallerico 1991 4 p Presented at the 1991 Institute of Electrical and Electronics Engineers (IEEE) Particle Accelerator Conference (PAC), San Francisco, 6-9 May 1991
(Contract W-7405-eng-36)
(DE91-011409; LA-UR-91-1425; CONF-910505-9) Avail: NTIS HC/MF A01

Los Alamos is extending the performance of the Friedman-type, high-current relativistic klystron amplifier (RKA) to the microsecond regime while attempting to achieve the gigawatt-level peak power capability that has been characteristic of the RKA at shorter pulse lengths. Currently the electron beam power into the device is about 1 GW in microsecond duration pulses, with an effort underway to increase the beam power to 2.5 GW. To date the device has yielded an RF modulated electron beam power of 350 MW, with up to 50 MW coupled into the waveguide. Several aspects of RKA operation under investigation that affect RKA beam bunching efficiency and amplifier gain include cavity tuning, beam diameter, beam current, and input RF drive power, and the development of an output coupler that efficiently couples the microwave power from the low impedance beam into rectangular waveguide operating in the dominant mode. Current results from experimental testing and code modelling are presented. DOE

N91-25333# Sandia National Labs., Albuquerque, NM.
EXPERIMENTS INVESTIGATING THE EFFECTS OF THE ACCELERATING GAP VOLTAGE PULSE ON THE ION FOCUSED (IFR) HIGH CURRENT ELECTRON RECIRCULATORS
M. G. Mazarakis, D. L. Smith, J. W. Poukey, J. S. Wagner, L. F. Bennett, W. R. Olson, B. N. Turman, K. R. Prestwich, and J. Wells 1991 4 p Presented at the 1991 Institute of Electrical and Electronics Engineers (IEEE) Particle Accelerator Conference (PAC), San Francisco, 6-9 May 1991
(Contract DE-AC04-76DP-00789)
(DE91-011495; SAND-90-2602; CONF-910505-21) Avail: NTIS HC/MF A01

The lifetime of the Ion Focusing Regime (IFR) channel following the pulsing of the post-accelerating gaps is critical for an open-ended, spiral recirculating electron linear accelerator. It dictates the number of allowable beam recirculations through the gap. In the case of a racetrack configuration, it is significant but not as critical, since the presence of the electron beam focuses the ions and lengthens the lifetime of the ion channel. It was established that pulsing the accelerating gap perturbs the IFR channel. However, for the parameters studied, the lifetime is long enough to allow at least four beam recirculations in a spiral device. In addition, cusp fields positioned upstream and downstream from the gap prevent it from perturbing the IFR channel. DOE

N91-25334*# Toledo Univ., OH. Dept. of Electrical Engineering.
A PARALLEL-PIPELINED ARCHITECTURE FOR A MULTI CARRIER DEMODULATOR M.S. Thesis Final Technical Report, Jan. 1989 - Aug. 1990
S. C. Kwatra, M. M. Jamali, and Linus P. Eugene Mar. 1991 176 p
(Grant NAG3-865)
(NASA-CR-188620; NAS 1.26:188620; DTVI-26) Avail: NTIS HC/MF A09 CSCL 09C

Analog devices have been used for processing the information on board the satellites. Presently, digital devices are being used because they are economical and flexible as compared to their analog counterparts. Several schemes of digital transmission can be used depending on the data rate requirement of the user. An economical scheme of transmission for small earth stations uses single channel per carrier/frequency division multiple access (SCPC/FDMA) on the uplink and time division multiplexing (TDM) on the downlink. This is a typical communication service offered to low data rate users in commercial mass market. These channels usually pertain to either voice or data transmission. An efficient digital demodulator architecture is provided for a large number of law data rate users. A demodulator primarily consists of carrier, clock, and data recovery modules. This design uses principles of parallel processing, pipelining, and time sharing schemes to process large numbers of voice or data channels. It maintains the optimum throughput which is derived from the designed architecture and from the use of high speed components. The design is optimized for reduced power and area requirements. This is essential for satellite applications. The design is also flexible in processing a group of a varying number of channels. The algorithms that are used are verified by the use of a computer aided software engineering (CASE) tool called the Block Oriented System Simulator. The data flow, control circuitry, and interface of the hardware design is simulated in C language. Also, a multiprocessor approach is provided to map, model, and simulate the demodulation algorithms mainly from a speed view point. A hypercude based architecture implementation is provided for such a scheme of operation. The hypercube structure and the demodulation models on hypercubes are simulated in Ada. Author

N91-25335*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
ARC/GAS ELECTRODE Patent Application
Richard M. Poorman, inventor (to NASA) and Jack L. Weeks, inventor (to NASA) (Rockwell International Corp., Canoga Park, CA.) 27 Mar. 1991 11 p
(NASA-Case-MFS-29766-1; NAS 1.71:MFS-29766-1; US-Patent-Appl-SN-677182) Avail: NTIS HC/MF A03 CSCL 09A

A gas/arc electrode is disclosed for use under vacuum conditions where a first housing encloses a second housing, with an end of the second housing extending through an opening in the first housing and having an outlet orifice. Provisions are made for circulating a coolant through the first housing to surround and cool the second housing. An electrical current and a gas, such as argon, as passed through the second housing, with the current flowing through a narrow stream of the ionized gas flowing through the outlet orifice to a workpiece to be treated. The second housing forms a chamber which has a cross sectional area, in a plane perpendicular to the direction of gas flow, of at least ten times the cross sectional area of the outlet orifice such that a gas pressure can be maintained in the chamber to reduce erosion of the chamber walls. NASA

N91-25787*# Bonneville Power Administration, Portland, OR. Telecommunications Systems Branch.
DELIVERY AND APPLICATION OF PRECISE TIMING FOR A TRAVELING WAVE POWERLINE FAULT LOCATOR SYSTEM

Michael A. Street *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 355-360 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 09C

N91-25788*# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Electrical Engineering.
PRECISE SYNCHRONIZATION OF PHASOR MEASUREMENTS IN ELECTRIC POWER SYSTEMS
Arun G. Phadke *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 361-365 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 09C

34 FLUID MECHANICS AND HEAT TRANSFER

Includes boundary layers; hydrodynamics; fluidics; mass transfer; and ablation cooling.

For related information see also *02 Aerodynamics* and *77 Thermodynamics and Statistical Physics.*

N91-25336# Johns Hopkins Univ., Columbia, MD. Chemical Propulsion Information Agency.
COMPUTATIONAL FLUID DYNAMICS CODE VALIDATION/CALIBRATION. JANNAF AIRBREATHING PROPULSION SUBCOMMITTEE WORKSHOP: HIGH-SPEED INLET FOREBODY INTERACTIONS
Camille T. Hudson, ed. Jan. 1991 103 p Workshop held in Reno, NV, 10-11 Jan. 1991
(Contract N00014-91-C-0001)
(CPIA-Publ-551) Avail: NTIS HC/MF A06

A summary, viewgraphs, and a transcript of discussions of a workshop on computational fluid dynamics code validation/calibration are presented. The workshop focused on inlet/forebody interactions in high-speed ramjets. For individual titles, see N91-25337 through N91-25349.

N91-25337# Science Applications International Corp., Fort Washington, PA. Fluid and Propulsion Sciences Operation.
OBSERVATIONS ON CFD AND TURBULENCE MODEL VALIDATION/CALIBRATION FOR THE SIMULATION OF HIGH-SPEED PROPULSIVE FLOWFIELDS
Sanford M. Dash *In* JHU, Computational Fluid Dynamics Code Validation/Calibration. JANNAF Airbreathing Propulsion Subcommittee Workshop: High-Speed Inlet Forebody Interactions Jan. 1991 p 3-30 (For primary document see N91-25336 17-34)
(SAIC/FW-TP-210) Avail: NTIS HC/MF A06

Observations on CFD and turbulence model validation/calibration for the simulation of high-speed propulsive flowfields are presented in the form of the view-graphs. The following topics are covered: the major pitfalls in the validation process; CFD codes/basic attributes; SAIC/FPSO CFD code philosophy; FNS and PNS computer codes with advanced thermochemistry; high speed propulsive problems analyzed by CFD models of increasing complexity; and four levels of code validation. Author

N91-25338*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TESTS IN HELIUM ILLUSTRATE HIGH MACH NUMBER INLET-FOREBODY INTERACTIONS
John Weidner and Carl Trexler *In* JHU, Computational Fluid Dynamics Code Validation/Calibration. JANNAF Airbreathing Propulsion Subcommittee Workshop: High-Speed Inlet Forebody Internactions Jan. 1991 p 31-48 (For primary document see N91-25336 17-34)
Avail: NTIS HC/MF A06

High Mach helium tests are described in the form of the view-graphs. The following topics are included: high-speed inlet-forebody interaction tests; helium tunnel; boundary layer approaching inlet; ramp surface pressure distribution; static pressure on ramp; and pressure variation across wedge and ramp. Author

N91-25339# Sverdrup Technology, Inc., Arnold AFS, TN.
CFD CALIBRATION AND APPLICATION TO THE DESIGN OF FLOW TAILORING DEVICES FOR SIMULATING FOREBODY INFLUENCES ON FIGHTER AIRCRAFT INLET FLOWS
D. K. Beale, J. C. Adams, and M. S. Collier (Arnold Engineering Development Center, Arnold Air Force Station, TN.) *In* JHU, Computational Fluid Dynamics Code Validation/Calibration. JANNAF Airbreathing Propulsion Subcommittee Workshop: High-Speed Inlet Forebody Interactions Jan. 1991 p 49-69 (For primary document see N91-25336 17-34)
Avail: NTIS HC/MF A06

CFD calibration and application to the design of flow tailoring devices for simulating forebody influences on fighter aircraft inlet flows is presented in the form of the view-graphs. The following subject areas are covered: free-jet test concept; free-jet test cell C-2 supersonic installation; role of CFD design of forebody simulators; CFD requirements from experimentalist perspective; forebody simulator design technology development plan; CFD calibration program; validation/calibration experiments; CFD model of free-jet configuration; and free-jet CFD calibration results. Author

N91-25340# North Carolina State Univ., Raleigh.
EXPERIMENTAL INVESTIGATION OF A GENERIC THREE-DIMENSIONAL SIDEWALL COMPRESSION SCRAMJET INLET AT MACH 10
Scott D. Holland *In* JHU, Computational Fluid Dynamics Code Validation/Calibration. JANNAF Airbreathing Propulsion Subcommittee Workshop: High-Speed Inlet Forebody Interactions Jan. 1991 p 71-85 (For primary document see N91-25336 17-34)
Avail: NTIS HC/MF A06

Experimental investigation of a generic 2-D sidewall compression scramjet inlet at Mach 10 is presented in the form of the view-graphs. The following subject areas are covered: propulsion-airframe integration; Mach 10 tunnel injection system; 2-D inviscid internal shock interactions; region of spillage due to internal shock structure; aerodynamic simulation; aerothermodynamic loading; and results from wind tunnel blockage tests. Author

N91-25341*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THE AEROSPACE PLANE DESIGN CHALLENGE: CREDIBLE COMPUTATIONAL FLUID DYNAMICS RESULTS
Unmeel B. Mehta *In* JHU, Computational Fluid Dynamics Code Validation/Calibration. JANNAF Airbreathing Propulsion Subcommittee Workshop: High-Speed Inlet Forebody Interactions Jan. 1991 p 87-92 (For primary document see N91-25336 17-34)
Avail: NTIS HC/MF A06 CSCL 20D

The aerospace plane design challenge is presented in the form of the view-graphs. The following topics are included: the CFD design technology development; CFD validation vs. measurable fluid dynamics validation; and discussion of results. Author

N91-25342# McDonnell-Douglas Research Labs., Saint Louis, MO.
COMPUTATION OF INLET/FOREBODY INTERACTION FLOWFIELDS
Ramesh K. Agarwal *In* JHU, Computational Fluid Dynamics Code Validation/Calibration. JANNAF Airbreathing Propulsion Subcommittee Workshop: High-Speed Inlet Forebody Interactions Jan. 1991 p 93-130 (For primary document see N91-25336 17-34)
Avail: NTIS HC/MF A06

Computation of inlet/forebody interaction flowfields is presented in the form of the view-graphs. The main objective was to develop 3-D Navier-Stokes capability which can be used to efficiently compute hypersonic, chemically reacting flowfields. Author

N91-25343*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A NUMERICAL STUDY OF HYPERSONIC FOREBODY/INLET INTEGRATION PROBLEM **c02**
Ajay Kumar *In* JHU, Computational Fluid Dynamics Code Validation/Calibration. JANNAF Airbreathing Propulsion Subcommittee Workshop: High-Speed Inlet Forebody Interactions Jan. 1991 p 131-154 (For primary document see N91-25336 17-34)
Avail: NTIS HC/MF A06 CSCL 01A

A numerical study of hypersonic forebody/inlet integration problem is presented in the form of the view-graphs. The following topics are covered: physical/chemical modeling; solution procedure; flow conditions; mass flow rate at inlet face; heating and skin friction loads; 3-D forebogy/inlet integration model; and sensitivity studies. Author

N91-25344*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
NAVIER-STOKES SIMULATION OF INLET FLOW FIELDS-EXPERIMENTAL VERIFICATION
Wei J. Chyu and Daniel P. Bencze *In* JHU, Computational Fluid Dynamics Code Validation/Calibration. JANNAF Airbreathing Propulsion Subcommittee Workshop: High-Speed Inlet Forebody Interactions Jan. 1991 p 155-177 (For primary document see N91-25336 17-34)
Avail: NTIS HC/MF A06 CSCL 20D

The objectives were to develop a state-of-the-art numerical capability for the prediction of internal and external flow fields, validate the Navier-Stokes solution for internal flows, treat realistic diffuser inlet systems, and provide a technical base for inlet system design. Progress is reported in viewgraph form. Author

N91-25345*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SENSITIVITY OF INLET PERFORMANCE PREDICTIONS TO CFD NUMERICAL AND PHYSICAL MODELING
T. A. Edwards and S. L. Lawrence *In* JHU, Computational Fluid Dynamics Code Validation/Calibration. JANNAF Airbreathing Propulsion Subcommittee Workshop: High-Speed Inlet Forebody Interactios Jan. 1991 p 179-195 (For primary document see N91-25336 17-34)
Avail: NTIS HC/MF A06 CSCL 20D

An overview is given of compressible Navier Stokes codes and up-wind solvers. Code validation efforts, inlet analysis requirements, and computational fluid dynamics modeling uncertainties are covered. Information is given in viewgraph form. Author

N91-25346# Pratt and Whitney Aircraft. West Palm Beach, FL.
VALIDATION OF CFD CODES FOR INLET FLOWS
Saadat A. Syed *In* JHU, Computational Fluid Dynamics Code Validation/Calibration. JANNAF Airbreathing Propulsion Subcommittee Workshop: High-Speed Inlet Forebody Interactions Jan. 1991 p 197-213 (For primary document see N91-25336 17-34)
Avail: NTIS HC/MF A06

Calibration requirements for computational fluid dynamics codes are given. Topics covered include laminar flow experiments, attached flow, separated flow, and shock/boundary layer interaction. Information is given in viewgraph form. Author

N91-25347# Grumman Aerospace Corp., Bethpage, NY.
COMPUTATIONAL SIMULATIONS FOR FIGHTER AND HYPERSONIC VEHICLE INLET-FOREBODY INTERACTIONS
Charles W. Boppe *In* JHU, Computational Fluid Dynamics Code Validation/Calibration. JANNAF Airbreathing Propulsion Subcommittee Workshop: High-Speed Inlet Forebody Interactions Jan. 1991 p 215-241 (For primary document see N91-25336 17-34)
Avail: NTIS HC/MF A06

Euler method characteristics, an F-14 fuselage geometry model and shock wave pattern predicted by Euler analysis, prediction of F-14 inlet pressure recovery levels, a fuselage induced inlet flow field comparison, avionic integration, and hypersonic vehicle inlet integration are among the topics covered. Information is given in viewgraph form. Author

N91-25348# McDonnell-Douglas Corp., Saint Louis, MO.
HIGH-SPEED FOREBODY-INLET CODE VALIDATION EXPERIENCE AT MCAIR
R. R. Cosner *In* JHU, Computational Fluid Dynamics Code Validation/Calibration. JANNAF Airbreathing Propulsion Subcommittee Workshop: High-Speed Inlet Forebody Interactions Jan. 1991 p 251-269 (For primary document see N91-25336 17-34)
Avail: NTIS HC/MF A06

The objectives of the validation were to establish the capabilities of the analysis code, define the requirements to attain the best results within the capabilities, and to evaluate the analysis code for specified engineering applications. Topics covered include products of the computational fluid dynamics (CFD) validation, levels of validation, key elements of the validation study, a 2-D inlet model, 2-D inlet model flow field features, the grid density effect on pitot pressure profiles, cowl pressure time histories, inlet surface pressure, inlet surface heating rate, and inlet CFD validation testing approaches. Information is given in viewgraph form. Author

N91-25349*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
CFD VALIDATION FOR FOREBODY INLET INTERACTIONS
J. G. Marvin *In* JHU, Computational Fluid Dynamics Code Validation/Calibration. JANNAF Airbreathing Propulsion Subcommittee Workshop: High-Speed Inlet Forebody Interactions Jan. 1991 p 271-296 (For primary document see N91-25336 17-34)
Avail: NTIS HC/MF A06 CSCL 20D

Topics covered include the computational fluid dynamics (CFD) task force philosophy, a road map for CFD code validation, computer code validation requirements for forebodies and inlets, the criteria for choosing recommended experiments, an all-body hypersonic experiment, and centerline heat transfer. Information is given in viewgraph form. Author

N91-25350# National Inst. of Standards and Technology, Gaithersburg, MD. Center for Computing and Applied Mathematics.
SPACE MARCHING DIFFERENCE SCHEMES IN THE NONLINEAR INVERSE HEAT CONDUCTION PROBLEM
A. S. Carasso 21 Nov. 1990 41 p
(PB91-144360; NISTIR-4482) Avail: NTIS HC/MF A03 CSCL 20D

The Lax-Richtmyer theory is used to study the error amplification properties of 18 space marching finite difference schemes, for the 1-D nonlinear inverse heat conduction problem. A non-dimensional parameter Omega, involving the time step Delta t, the effective thermal diffusivity alpha, and the distance l from the sensor to the active surface, provides a measure of the numerical difficulty of the inverse calculation. All 18 schemes are unstable and blow-up like 10(sup lambda Omega), where the constant lambda depends on the particular numerical method. However, there are substantial differences in the lambda's, and some newly constructed algorithms, employing forward time differences at nonadjacent mesh points, are shown to produce relatively low values of lambda. Using synthetic noisy data, a nonlinear reconstruction problem is considered for which Omega = 25. This problem simulates heat transfer in gun barrels when a shell is fired. It is shown that while most of the 18 schemes cannot recover the thermal pulses at the gun tube wall, two of

the new methods provide reasonable accurate results. A tendency to underestimate peak values in fast, narrow thermal pulses, is also noted. GRA

N91-25351*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
REVIEW AND TEST OF CHILLDOWN METHODS FOR SPACE-BASED CRYOGENIC TANKS
David J. Chato and Rafael Sanabria 1991 26 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; sponsored by AIAA, SAE, ASME, and the American Society for Electrical Engineers
(NASA-TM-104458; E-6299; NAS 1.15:104458; AIAA-91-1843)
Avail: NTIS HC/MF A03 CSCL 20D

The literature for tank chilldown methods applicable to cryogenic tankage in the zero gravity environment of earth orbit is reviewed. One method is selected for demonstration in a ground based test. The method selected for investigation was the charge-hold-vent method which uses repeated injection of liquid slugs, followed by a hold to allow complete vaporization of the liquid and a vent of the tank to space vacuum to cool tankage to the desired temperature. The test was conducted on a 175 cubic foot, 2219 aluminum walled tank weighing 329 pounds, which was previously outfitted with spray systems to test nonvented fill technologies. To minimize hardware changes, a simple control-by-pressure scheme was implemented to control injected liquid quantities. The tank cooled from 440 R sufficiently in six charge-hold-vent cycles to allow a complete nonvented fill of the test tank. Liquid hydrogen consumed in the process is estimated at 32 pounds. Author

N91-25352*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
AEROACOUSTIC AND AERODYNAMIC APPLICATIONS OF THE THEORY OF NONEQUILIBRIUM THERMODYNAMICS
W. Clifton Horne, Charles A. Smith, and Krishnamurty Karamcheti (Florida Agricultural and Mechanical Univ., Tallahassee.) Washington Jun. 1991 26 p
(NASA-TP-3118; A-90084; NAS 1.60:3118) Avail: NTIS HC/MF A03 CSCL 20D

Recent developments in the field of nonequilibrium thermodynamics associated with viscous flows are examined and related to developments to the understanding of specific phenomena in aerodynamics and aeroacoustics. A key element of the nonequilibrium theory is the principle of minimum entropy production rate for steady dissipative processes near equilibrium, and variational calculus is used to apply this principle to several examples of viscous flow. A review of nonequilibrium thermodynamics and its role in fluid motion are presented. Several formulations are presented of the local entropy production rate and the local energy dissipation rate, two quantities that are of central importance to the theory. These expressions and the principle of minimum entropy production rate for steady viscous flows are used to identify parallel-wall channel flow and irrotational flow as having minimally dissipative velocity distributions. Features of irrotational, steady, viscous flow near an airfoil, such as the effect of trailing-edge radius on circulation, are also found to be compatible with the minimum principle. Finally, the minimum principle is used to interpret the stability of infinitesimal and finite amplitude disturbances in an initially laminar, parallel shear flow, with results that are consistent with experiment and linearized hydrodynamic stability theory. These results suggest that a thermodynamic approach may be useful in unifying the understanding of many diverse phenomena in aerodynamics and aeroacoustics. Author

N91-25353 Brown Univ., Providence, RI.
COMPUTATIONS IN OPTIMAL CONTROL OF NAVIER-STOKES EQUATIONS Ph.D. Thesis
Mihir Chandravadan Desai 1990 158 p
Avail: Univ. Microfilms Order No. DA9101757

The control problem for the cavity (with both top and bottom surfaces moving) is to find the value of the top velocity (given bottom velocity) such that the flow separates at a desired horizontal line location. For the channel, the problem of minimizing appropriate cost functions (vorticity, back flow) by injecting (sucking) flow in the corner region of the channel is considered. The minimization is carried out using preconditioned conjugate gradient method and this is reduced to solving a series of Stokes problems. Hence an efficient solution technique for the Stokes problem is crucial. Two preconditionings are proposed for solving the Stokes problem by the conjugate gradient method. The first one is an elementwise preconditioning for a variant of the Uzawa method which accelerates its performance by more than a factor of two, and more importantly, the improvement is even better for finer meshes for the problems considered. The second preconditioning can be used in general for any quadratic programming problem with linear constraints (e.g., Stokes problem) and the numerical computations show that it yields a very efficient Stokes solver for the channel problem. Alternate ways were considered of preconditioning (instead of Stokes) the conjugate gradient method by using approximations for the discretized Laplace operator for velocity that are more easily inverted and require less storage. Methods mentioned above and the computations show that the combination yields a very efficient solution scheme at least at low Reynolds numbers. Based upon the numerical calculations, the augmented Lagrangian method using the preconditioned conjugate gradient method is a very feasible solution method for the control problems considered. Dissert. Abstr.

N91-25354 California Univ., San Diego.
AN EXPERIMENTAL STUDY OF THE ORIGIN OF OBLIQUE VORTEX SHEDDING FROM TWO-DIMENSIONAL BLUFF BODIES Ph.D. Thesis
Mustapha Hammache 1990 97 p
Avail: Univ. Microfilms Order No. DA9110722

An experimental study of the origin of non-parallel vortex shedding observed in the laminar wake of finite aspect ratio circular cylinders is described. A method to promote parallel vortex shedding in the wake of cylinders, which we called the control cylinder technique was developed. This technique enabled us to control the angle of the shed vortex filaments with respect to the axis of the cylinder. The amount of control was sufficient to create oblique vortex shedding of different angles as well as parallel vortex shedding (zero angle). A non-symmetric spanwise mean pressure distribution, which induces a spanwise flow in the base region of the cylinder, was identified as the mechanism responsible for the oblique shedding. Parallel vortex shedding, attained through use of our control technique, revealed a symmetric pressure distribution and no spanwise flow along the cylinder base. The control technique was also used to study the transition to turbulence and the downstream evolution of the wake in parallel and oblique vortex shedding. In this regard, it was determined that oblique vortex streets undergo the transition to turbulence at lower Reynolds numbers than parallel vortex streets. The secondary vortex structure, which is observed after the Karman vortex street has decayed, was found to be parallel regardless of the condition of shedding in the near wake. The frequency of the secondary vortices was, therefore, independent of the Strouhal frequency which is measured in the near wake. This result is in agreement with the changing hydrodynamic stability as the mechanism for the rearrangement of the wake and accounts for the discrepancy in the reported values of the ratio of the frequency in the far wake to the Strouhal frequency. Dissert. Abstr.

N91-25355 Old Dominion Univ., Norfolk, VA.
AN EXTENSION OF ESSENTIALLY NONOSCILLATORY SHOCK-CAPTURING SCHEMES TO MULTIDIMENSIONAL SYSTEMS OF CONSERVATION LAWS Ph.D. Thesis
Jay Casper 1990 175 p
Avail: Univ. Microfilms Order No. DA9110250

In recent years, a class of numerical schemes for solving hyperbolic partial differential equations has been developed which generalizes the first-order method of Godunov to arbitrary order of accuracy. High-order accuracy is obtained, wherever the solution is smooth, by an essentially non-oscillatory (ENO) piecewise

polynomial reconstruction procedure, which yields high-order pointwise information from the cell averages of the solution at a given point in time. When applied to piece-wise smooth initial data, this reconstruction enables a flux computation that provides a time update of the solution which is of high-order accuracy, wherever the function is smooth, and avoids a Gibbs phenomenon at discontinuities. The promising results of Harten et al., in the use of ENO schemes in solving the one-dimensional Euler equations of gas dynamics, have aroused considerable interest in the aerodynamic community. However, the application of these schemes to areas of scientific and industrial interest, such as aircraft configuration, obviously requires compressible flow solutions in more than one spatial dimension. This extension of ENO schemes to multi-dimensional applications is presented. In particular, a two-dimensional extensional extension is proposed for the Euler equations of gas dynamics. Among the issues to be considered in this extension are the achievement of formal high-order two-dimensional spatial accuracy, the implementation of boundary conditions, and applications to general curvilinear coordinates. Dissert. Abstr.

N91-25356 Washington Univ., Seattle.
NUMERICAL SIMULATION OF OBLIQUE DETONATION AND SHOCK-DEFLAGRATION WAVES WITH A LAMINAR BOUNDARY LAYER Ph.D. Thesis
Chuck Chen 1990 132 p
Avail: Univ. Microfilms Order No. DA9108454

The possibility of using shock-induced combustion or an oblique detonation wave in hypersonic air breathing engines has been investigated during the last few years. This study examines the interaction of a shock wave and a laminar boundary layer in a combustible mixture. The Navier-Stokes equations with a seven species combustion model are cast into the form of a conservation law so that imbedded discontinuities are captured without oscillations. The algorithm developed employs the point implicit TVD MacCormack method. In the preheated flow shock detonation cases, the scheme agrees well with published results and with theoretical analyses. An exothermic calculation was performed using a diagonal method. The obtained results were identical to results obtained using the point implicit method, with a 20 percent reduction in CPU time. Solutions of flow with shock-deflagrations in oblique shock/ boundary layer causes a catastrophic change, such as separation, in the overall flow field although there is a significant effect. Small regions of flow separation were observed in the ram accelerator oblique detonation cases where the detonation waves interact with the boundary layer at the projectile surface. Under all the given conditions, there is no evidence that unsteady flow results from the interaction of the shock-deflagration or detonation wave system and the boundary layer.
Dissert. Abstr.

N91-25357 California Univ., San Diego.
THE NEAR-FIELD DYNAMICS AND ENTRAINMENT FIELD OF SUBMERGED AND NEAR-SURFACE JETS Ph.D. Thesis
Dorian Liepmann 1990 163 p
Avail: Univ. Microfilms Order No. DA9110726

An experimental investigation on the effect of a free surface on the near field behavior of a round jet is discussed. The work focuses on the interaction between the vortex dynamics and entrainment characteristics of both submerged and near surface jets. Dissert. Abstr.

N91-25358 Virginia Polytechnic Inst. and State Univ., Blacksburg.
AN EXPERIMENTAL STUDY OF A THREE-DIMENSIONAL PRESSURE-DRIVEN TURBULENT BOUNDARY LAYER Ph.D. Thesis
Semih Mehmet Olcmen 1990 502 p
Avail: Univ. Microfilms Order No. DA9109414

A 3-D pressure driven turbulent boundary layer created by an idealized wing-body junction flow is experimentally studied. The body used is a 3:2 elliptical nosed NASA 0020 tailed symmetric profile which has a chord length of 30.5 cm, maximum thickness of 7.17 cm, and height of 22.9 cm. The nominal reference velocity of the flow is 27 m/sec and the Reynolds number based on the momentum thickness at 0.75 chord upstream of the body on the centerline of the tunnel is approx. = 5936. The data presented include time-mean static pressure, skin friction magnitude and direction on the wall, as well as the mean velocity and all Reynolds stresses at several stations on a line determined with the mean velocity vector component parallel to the wall in the layer where the normal stress is maximum. The mean velocity and stress data were obtained both with hot-wire (HW) and laser-Doppler-velocimeter (LDV) techniques. This gave a chance to study the uncertainties on the mean velocity and the stresses extensively. Pressure distributions on the wing and on the bottom plate were obtained with a Scanivalve and an inclined manometer. The skin friction velocity is not the scale of the turbulence in such a flow. A collection of 3-D turbulent boundary layer data including the present study is used to investigate the concept of the Law of the Wall velocity profile and the limitations of eddy-viscosity turbulence models in 3-D flows. For this purpose, several Law-of-the-Wall velocity profile models and eddy-viscosity models were tested. Dissert. Abstr.

N91-25359 Kansas Univ., Lawrence.
INCOMPRESSIBLE BOUNDARY LAYER TRANSITION FLIGHT EXPERIMENTS OVER A NONAXISYMMETRIC FUSELAGE FOREBODY AND COMPARISONS WITH LAMINAR BOUNDARY LAYER STABILITY THEORY Ph.D. Thesis
Paul M. H. W. Vijgen 1990 395 p
Avail: Univ. Microfilms Order No. DA9110931

Analyses of previous boundary-layer transition experiments over axisymmetric bodies indicates a potential for achieving substantial amounts of laminar flow over such shapes. Achievement of natural laminar flow over portions of nonlifting aircraft geometries, such as fuselage to forebodies, tip tanks or engine nacelles, could significantly contribute to the reduction of total aircraft viscous drag. A modern surface-panel method, a streamwise boundary-layer analysis method, and streamwise linear stability theory (E(sup n)-method) are used to correlate several previous transition measurements along axisymmetric geometries to study the transition characteristics of a nonaxisymmetric body geometry, a flight investigation was conducted to measure the transition location and analyze the mode of transition over the nonaxisymmetric forebody of an existing light twin-engine propeller-driven airplane. A summary of the inviscid flow field over the forebody of the aircraft at various body angles is presented, indicating the relatively small magnitude of inviscid crossflow along the forebody at typical cruising attitudes. The transition instrumentation installed in the airplane fuselage is described, together with relative surface-waviness measurements along the forebody. The macroscopic location of the transitional front, obtained from arrayed hot-film sensors, is presented for a matrix of flight conditions with various unit-Reynolds numbers, angles of attack and sideslip, and engine power settings. Dissert. Abstr.

N91-25360 Iowa State Univ. of Science and Technology, Ames.
A PRIMITIVE VARIABLE, STRONGLY IMPLICIT CALCULATION PROCEDURE FOR TWO AND THREE-DIMENSIONAL UNSTEADY VISCOUS FLOWS: APPLICATIONS TO COMPRESSIBLE AND INCOMPRESSIBLE FLOWS INCLUDING FLOWS WITH FREE SURFACES Ph.D. Thesis
Kuo-Huey Chen 1990 227 p
Avail: Univ. Microfilms Order No. DA9110487

A coupled solution procedure is described for solving the time-dependent Navier-Stokes equation in body-fitted non-orthogonal curvilinear coordinates for both compressible and incompressible flows in two and three dimensions. For the two-dimensional compressible form of equations, this approach employs the strong conservation law form of the governing equations but uses primitive variables rather than the more traditional conservative variables as unknowns. A coupled modified strongly implicit procedure (CMSIP) is used to efficiently solve the Newton-linearized algebraic equations. It appears that this

procedure is effective for Mach numbers ranging from the incompressible limit to supersonic. Generally, smoothing was not needed to control spatial oscillations in pressure for subsonic flows despite the use of central differences. Dual time stepping was found to further accelerate convergence for steady flows. Sample calculations, including steady and unsteady low Mach number internal and external flows and a steady shock-boundary layer interaction flow, illustrate the capability of the present solution algorithm. For three-dimensional incompressible liquid flows with the presence of free surfaces, this approach, coupled with the artificial compressibility method, is used to solve the Newton-linearized algebraic equations for the primitive variables. A true unsteady three-dimensional flow simulation was obtained for liquid sloshing flow in a partially filled spherical container undergoing a general motion characteristic of that experienced by a spin-stabilized satellite. It appears that this unified approach can handle compressible and incompressible flows very effectively. Author

N91-25361 Utah Univ., Salt Lake City.
THE SPECTRAL-COMPACT FINITE DIFFERENCE TECHNIQUE FOR DIRECT NUMERICAL SIMULATION OF TURBULENT FLOWS Ph.D. Thesis
Randy Clarksean 1990 138 p
Avail: Univ. Microfilms Order No. DA9108039

The spectral-compact finite difference technique is developed to study mixing through the direct numerical simulation of spatially developing incompressible mixing layers. The numerical technique is a combination of the spectral method (Fourier series expansion) and the compact finite difference method. The compact finite difference method is fourth-order accurate in space and exhibits good phase error characteristics. A pressure solver is developed to insure the conservation of mass within the numerical solution using the compact and spectral methods. The pressure solver is tridiagonal in nature, and calculates the pressure field in wave space before transforming the solution back to real space. This algorithm was implemented to study two and three dimensional constant density mixing layers. The numerical method was validated by comparing the numerical results to laboratory observations and experimental data. The computer implementation of the numerical method correctly calculated the growth rate of the momentum thickness, fluctuating velocity components, vortical structures, and the mixing characteristics of a mixing layer. Dissert. Abstr.

N91-25362 Old Dominion Univ., Norfolk, VA.
NAVIER-STOKES SIMULATIONS OF FLOWS ABOUT COMPLEX CONFIGURATIONS USING DOMAIN DECOMPOSITION TECHNIQUES Ph.D. Thesis
Kamran Fouladi-Semnani 1990 154 p
Avail: Univ. Microfilms Order No. DA9110255

An algorithm is developed to obtain numerical simulations of flows about complex configurations composed of multiple and nonsimilar components with arbitrary geometries. The algorithm uses a hybridization of the domain decomposition techniques for grid generation and to reduce the computer memory requirement. Three dimensional, Reynolds-averaged, unsteady, compressible, and complete Navier-Stokes equations are solved on each of the subdomains by a fully-vectorized, finite-volume, upwind-biased, approximately factored, and multigrid method. The effect of Reynolds stresses is incorporated through an algebraic turbulence model with several modifications for interference flows. The present algorithm combines the advantages of an efficient, geometrically conservative, minimally and automatically dissipative algorithm with advantages and flexibility of domain decomposition techniques. The algorithm is used to simulate supersonic flows over two-dimensional profiles and a body of revolution at high angles of attack. The suitability of the baseline solution algorithm is examined to gain a better understanding of this class of flows. The grid overlapping is tested by obtaining the solution of a supersonic flow over a blunt-nose-cylinder at high angles of attack using a composite of overlapped grids. To accomplish one of the main objectives, the algorithm is then applied to simulate the supersonic flow over an ogive-nose-cylinder near and inside a cavity. The cylinder is attached to an offset L-shaped sting when placed above the cavity opening. Dissert. Abstr.

N91-25363 Delaware Univ., Newark.
AN ANALYSIS OF VISCOELASTIC FLOW SIMULATIONS Ph.D. Thesis
Haiqing Gong 1990 165 p
Avail: Univ. Microfilms Order No. DA9109907

Linear stability of a time-marching scheme was studied using the Maxwell/Oldroyd model which shows that the fully-implicit scheme is unstable for the viscoelastic flow. This feature is found to be inherent to the numerical scheme since it is directly associated with the structure of the coefficient matrix of the governing equation system. However, this feature vanishes if an additional viscosity or divergence-free condition is taken into account during the numerical computation. Furthermore, a computational nonlinear interaction between the velocity field and the stress field is investigated. Such an interaction causes an accumulation of a nonphysical (false) energy which contributes to the breakdown of simulations. A stabilization method, filtering technique, is designed to suppress the false energy. By controlling the order of the filter, the damping can be adjusted to fit the characteristics of flows to achieve a higher numerical accuracy. A numerical experiment using the Oldroyd-B model in a 4:1 contraction shows that the filter can achieve a higher (D sub e)(sub limit) than the upwind scheme. The stress singularity of the Maxwell fluid, induced by a boundary discontinuity is investigated. The magnitude of the stress singularity is proportional to the Weissenberg number and to the degree of the boundary discontinuity. Therefore, even for a grid which does not locate at the boundary singularity, the stress and the stress gradient levels at that grid can increase with the Weissenberg number. Dissert. Abstr.

N91-25364*# State Univ. of New York, Buffalo. Dept. of Mechanical and Aerospace Engineering.
LARGE EDDY SIMULATIONS AND DIRECT NUMERICAL SIMULATIONS OF HIGH SPEED TURBULENT REACTING FLOWS Semiannual Report, 1 Nov. 1990 - 1 May 1991
Peyman Givi, C. K. Madnia, C. J. Steinberger, and A. Tsai 1991 61 p
(Grants NAG1-1122; NAG3-1011)
(NASA-CR-188599; NAS 1.26:188599) Avail: NTIS HC/MF A04 CSCL 20D

This research is involved with the implementations of advanced computational schemes based on large eddy simulations (LES) and direct numerical simulations (DNS) to study the phenomenon of mixing and its coupling with chemical reactions in compressible turbulent flows. In the efforts related to LES, a research program was initiated to extend the present capabilities of this method for the treatment of chemically reacting flows, whereas in the DNS efforts, focus was on detailed investigations of the effects of compressibility, heat release, and nonequilibrium kinetics modeling in high speed reacting flows. The efforts to date were primarily focussed on simulations of simple flows, namely, homogeneous compressible flows and temporally developing hign speed mixing layers. A summary of the accomplishments is provided. Author

N91-25365*# Arizona State Univ., Tempe. Dept. of Mechanical and Aerospace Engineering.
NEAR-WALL MODELING OF COMPRESSIBLE TURBULENT FLOW Semiannual Progress Report, 1 Jan. - 30 Jun. 1991
Ronald M. C. So 30 Jun. 1991 79 p
(Grant NAG1-1080)
(NASA-CR-188608; NAS 1.26:188608) Avail: NTIS HC/MF A05 CSCL 20D

A near-wall two-equation model for compressible flows is proposed. The model is formulated by relaxing the assumption of dynamic field similarity between compressible and incompressible flows. A postulate is made to justify the extension of incompressible models to ammount for compressibility effects. This requires formulation the turbulent kinetic energy equation in a form similar to its incompressible counterpart. As a result, the compressible

dissipation function has to be split into a solenoidal part, which is not sensitive to changes of compressibility indicators, and a dilatational part, which is directly affected by these changes. A model with an explicit dependence on the turbulent Mach number is proposed for the dilatational dissipation rate. Author

N91-25366# National Aerospace Lab., Tokyo (Japan).
OBSERVATION OF LAMINAR BOUNDARY LAYER TRANSITION ON LIGHT MONOPLANE WING SURFACE
Takeshi Ohnuki, Yushi Terui, Yukio Kamata, and Nobuhiko Kamiya Sep. 1990 15 p In JAPANESE; ENGLISH summary
(NAL-TR-1077; ISSN-0389-4010) Avail: NTIS HC/MF A03

A series of flight tests were carried out to visualize the boundary layer transition on a wing of the FUJI FA-200X. The transition location was marked out by use of sublimating chemicals. The agreement between theoretical and experimental results was very good. The transition Reynolds number was about 1.3 million. The experimental procedure and the theoretical approaches are presented. Author

N91-25367*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
CHARACTERIZATION OF FLOW IN A SCROLL DUCT Final Report, Nov. 1983 - Jan. 1985
E. K. Begg and J. C. Bennett Jan. 1985 45 p
(Grant NAG3-484)
(NASA-CR-188612; NAS 1.26:188612) Avail: NTIS HC/MF A03
CSCL 20D

A quantitative, flow visualization study was made of a partially elliptic cross section, inward curving duct (scroll duct), with an axial outflow through a vaneless annular cutlet. The working fluid was water, with a Re(d) of 40,000 at the inlet to the scroll duct, this Reynolds number being representative of the conditions in an actual gas turbine scroll. Both still and high speed moving pictures of fluorescein dye injected into the flow and illuminated by an argon ion laser were used to document the flow. Strong secondary flow, similar to the secondary flow in a pipe bend, was found in the bottom half of the scroll within the first 180 degs of turning. The pressure field set up by the turning duct was strong enough to affect the inlet flow condition. At 90 degs downstream, the large scale secondary flow was found to be oscillatory in nature. The exit flow was nonuniform in the annular exit. By 270 degs downstream, the flow appeared unorganized with no distinctive secondary flow pattern. Large scale structures from the upstream core region appeared by 90 degs and continued through the duct to reenter at the inlet section. Author

N91-25368# Technische Univ., Delft (Netherlands).
FREQUENCY ANALYSIS OF FLUIDS AND FLUID-STRUCTURE SYSTEMS M.S. Thesis
Ruben Manuel Sylvest Schulkes 1991 149 p
(ETN-91-99428) Avail: NTIS HC/MF A07

The motion and eigenfrequencies of fluids in rigid and flexible containers is studied with consideration of the linearized equations, that is, starting from the static configuration of the system only small perturbations are considered with respect to this static state so that all nonlinear products of small quantities may be neglected. This procedure implies that the static configuration of the system must be known. For a fluid with a capillary free surface this means that the shape of the static capillary free surface has to be determined. A solution procedure for this problem is found. Oscillations of an inviscid fluid subjected to edge constraints are studied analytically and it is shown how the problem can be treated when the conditions on the capillary surface are rewritten by means of Green's functions. The finite element method is used to discretize the equations governing the motion of an incompressible, viscous fluid with a capillary free surface. This leads to a generalized eigenvalue problem solvable by an inverse iteration procedure which is effective in calculating eigenfrequencies of fluid oscillations in complex geometries. Oscillations of a viscous fluid in a flexible container are studied for two geometries. ESA

N91-25369# Sandia National Labs., Albuquerque, NM.
THE DISTRIBUTION OF MOISTURE BENEATH A TWO-DIMENSIONAL SURFACE SOURCE
M. J. Martinez and D. F. McTigue Mar. 1991 43 p
(Contract DE-AC04-76DP-00789)
(DE91-010720; SAND-90-0252) Avail: NTIS HC/MF A03

The distribution of moisture beneath a 2-D strip source is analyzed by applying the quasi-linear approximation. The source is described by specifying either the moisture content or the infiltration rate. A water table is specified at some depth, D, below the surface, the depth varying from shallow to semi-infinite. Numerical solutions are determined, via the boundary integral equation method, as a function of material sorptivity, alpha, the width of the strip source, 2L, and the depth to the water table. The moisture introduced at the source is broadly spread below the surface when alpha L (much less than) 1, for which absorption by capillary forces is dominant over gravity induced flow. Conversely, the distribution becomes finger-like along the vertical when alpha L (much greater than) 1, where gravity is dominant over absorption. For a source described by specifying the moisture content, the presence of a water table at finite depth influences the infiltration through the source when alpha D is less than about 4; infiltration rates obtained when the water table depth is semi-infinite are of sufficient accuracy for greater values of alpha D. When the source is described by a specified infiltration flux, the maximum allowable value of this flux for which the material beneath the source remains unsaturated is determined as a function of nondimensional sorptivity and depth to the water table. DOE

N91-25370# Oak Ridge National Lab., TN.
HEAT TRANSFER TO TURBULENT AND LAMINAR FALLING LIQUID FILMS
H. Limberg (Deutsche Akademie der Wissenschaften, Berlin, German D.R.) 1991 19 p
(Contract DE-AC05-84OR-21400)
(DE91-011342; ORNL-tr-90/20) Avail: NTIS HC/MF A03

The distribution of temperature in a falling liquid film running down a vertical plane (heated or cooled) wall is determined on the basis of the equation of heat transfer with boundary and initial conditions corresponding to a constant temperature T(sub 0) of the wall and a constant temperature T(sub 1) within the whole entrance section of the film. A separation method yields a Sturm-Liouville eigenvalue problem being solved numerically by means of finite differences. Several tables show the first eight eigenvalues, eigenfunctions and Fourier coefficients belonging to some Reynolds numbers. A diagram gives the theoretically calculated Nusselt number over mean Reynolds number Re(sub 0) together with Wilke's experimental data being in good agreement for such Re(sub 0) corresponding to a turbulent film and to a laminary film without rippling. DOE

N91-25371# Lawrence Livermore National Lab., CA.
TOPAZ2D PLANETARY BOUNDARY CONDITION
A. B. Shapiro Mar. 1991 13 p
(Contract W-7405-eng-48)
(DE91-011513; UCRL-ID-106855) Avail: NTIS HC/MF A03

TOPAZ2D is a general purpose transient nonlinear heat transfer code used to calculate the temperature response of 2-dimensional planar and axisymmetric bodies. A planetary boundary condition has been added to the code. TOPAZ2D with this boundary condition can be used to calculate the transient ground surface temperature signature. The code allows for the introduction and arbitrary distribution of any number of above and below ground objects. DOE

N91-25372# Lawrence Livermore National Lab., CA.
AN EFFICIENT SECOND-ORDER PROJECTION METHOD FOR VISCOUS INCOMPRESSIBLE FLOW
J. B. Bell, L. H. Howell, and P. Colella (California Univ., Berkeley.) 2 Apr. 1991 9 p Presented at the 10th AIAA Computational Fluid Dynamics Conference in Conjunction with the 22nd AIAA Fluid Dynamics, Plasma Dynamics and Lasers Conference and the 26th AIIA Thermophysics Conference, Honolulu, 24-26 Jun.

1991
(Contract W-7405-eng-48)
(DE91-011533; UCRL-JC-105252; CONF-910651-4) Avail: NTIS HC/MF A02

In this paper we describe a second-order projection method for the time-dependent, incompressible Navier-Stokes equations. The method is a second-order fractional step scheme in which one first solves diffusion-convection equations to determine intermediate velocities which are then projected onto the space of divergence-free vector fields. The diffusion-convection step uses a specialized second-order Godunov method for differencing the nonlinear convective terms that is conservative and free-stream preserving and provides a robust treatment of the nonlinearities at high Reynolds number. The projection is based on cell-centered centered difference approximations to divergence and gradient operators with the resulting linear system solved using a multigrid relaxation scheme. We apply the method to vortex spindown in a box to validate the numerical convergence of the method and to measure its overall performance. DOE

N91-25373# Lawrence Livermore National Lab., CA.
VORTICITY INTENSIFICATION AND TRANSITION TO TURBULENCE IN A THREE-DIMENSIONAL SHEAR FLOW
D. L. Marcus and J. B. Bell 1991 13 p Presented at the 10th AIAA Computational Fluid Dynamics Conference in Conjunction with the 22nd AIAA Fluid Dynamics, Plasma Dynamics and Lasers Conference and the 26th AIIA Thermophysics Conference, Honolulu, 24-26 Jun. 1991
(Contract W-7405-eng-48)
(DE91-011538; UCRL-JC-107011; CONF-910651-5) Avail: NTIS HC/MF A03

The evolution of a perturbed vortex tube in a triply periodic domain is studied by means of a second-order projection method for the incompressible Euler equations. We observe that, within the limits of grid resolution, the vorticity becomes unbounded. The onset of the apparent singularity is accompanied by a decay in the mean kinetic energy. In the post-singularity regime, we observe reconnection events, continued decay of the mean kinetic energy, and the emergence of a Kolmogorov (k(exp -5/3)) range in the energy spectrum. DOE

N91-25374# Lawrence Livermore National Lab., CA.
TOPAZ2D VALIDATION STATUS REPORT FOR DECEMBER 1990
M. Drayton Dec. 1990 95 p
(Contract W-7405-eng-48)
(DE91-011776; UCRL-ID-106550) Avail: NTIS HC/MF A05

A code verification of TOPAZ2D, a two-dimensional implicit finite element computer code for heat transfer analysis, developed at Lawrence Livermore National Laboratory is performed. This code verification is done through a comparison of the numerical solution generated by TOPAZ2D to the exact analytical solution. Twenty-seven one dimensional boundary value problems are examined and divided into four categories: plane linear steady; plane steady nonlinear; plane transient linear; and plane transient nonlinear. On all problems examined, TOPAZ2D compared well to the analytical solution. The conclusions obtained from this study are: (1) nonlinear convergence must be achieved before trying to reduce truncation errors through use of a smaller grid size; (2) cubic spline interpolation can improve the accuracy as well as increase the domain of nonlinear convergence; and (3) richardson's extrapolation can improve the results of linear and nonlinear problems. DOE

N91-25375# Sandia National Labs., Albuquerque, NM.
EFFECT OF THE GRID SYSTEM ON HEAT TRANSFER COMPUTATIONS FOR HIGH SPEED FLOWS
K. A. Hoffmann, M. S. Siddiqui (Texas Univ., Austin.), and W. H. Rutledge 1991 10 p
(Contract DE-AC04-76DP-00789)
(DE91-010874; SAND-91-0884C) Avail: NTIS HC/MF A02

Difficulties in the accurate heat transfer computation of high speed, blunt body flows have been encountered by numerous researchers. The primary reason for these difficulties has been shown to be the grid dependency of the wall flux quantities. Obviously, the accuracy of the computed heat fluxes will, to a certain extent, depend on the particular numerical scheme employed. The flux vector splitting technique is studied. An attempt was made to develop procedures which will provide guidelines for selecting appropriate grid systems and, in particular, the grid line distribution near the surface for accurate heat transfer computations. The results have clearly shown the dependency of the heat flux quantities on the grid system. In addition, it is shown that changes in flow Mach number and/or Reynolds number may require further refinement of the grid system. DOE

N91-25376# Los Alamos National Lab., NM.
LOW-TEMPERATURE FLOW VISUALIZATION OF THERMALLY-CONVECTING LIQUID HELIUM
T. Sullivan, R. E. Ecke, and V. Steinberg 1991 10 p Presented at the 8th Oregon Conference on LT Physics, Washington, 14-16 Jan. 1991
(Contract W-7405-eng-36)
(DE91-011383; LA-UR-91-1257; CONF-910170-3) Avail: NTIS HC/MF A02

We discuss low-temperature flow visualization of thermal convection in 3-He-superfluid 4-He mixtures. Density differences induced by the spatially-varying temperature field of the convecting fluid are imaged using the optical shadowgraph method. Details of the construction of the convection cell and the implementation of optical shadowgraph at low temperatures are presented. Results are shown for strongly turbulent flows to demonstrate the methods. DOE

N91-25377# Lawrence Livermore National Lab., CA.
CONSERVATIVE FRONT-TRACKING FOR INVISCID COMPRESSIBLE FLOW
J. B. Bell, M. L. Welcome, and P. Colella (California Univ., Berkeley.) Apr. 1991 11 p Presented at the 10th AIAA Computational Fluid Dynamics Conference in Conjunction with the 22nd AIAA Fluid Dynamics, Plasma Dynamics and Lasers Conference and the 26th AIIA Thermophysics Conference, Honolulu, 24-26 Jun. 1991
(Contract W-7405-eng-48)
(DE91-011534; UCRL-JC-105251; CONF-910651-3) Avail: NTIS HC/MF A03

In this paper we describe a front-tracking algorithm for modeling the propagation of discontinuous waves in two space dimensions. The algorithm uses a volume-of-fluid representation of the front in which the local frontal geometry is reconstructed from the state information on either side of the discontinuity and the Rankine-Hugoniot relations. The algorithm is coupled to an unsplit second-order Godunov algorithm and is fully conservative, maintaining conservation at the front. The combination of a volume-of-fluid representation of the front and a fully conservative algorithm leads to a robust high resolution method that easily accommodates changes in the topology of the front as well as kinks arising when a tracked front interacts with a captured discontinuity. The Godunov/tracking integration scheme is coupled to a local adaptive mesh refinement algorithm that selectively refines regions of the computational grid to achieve a desired level of accuracy. An example showing the combination of tracking and local refinement is presented. DOE

N91-25378# California Univ., Berkeley.
THREE DIMENSIONAL VORTEX METHODS FOR THE ANALYSIS OF WAVE PROPAGATION ON VORTEX FILAMENTS Ph.D. Thesis
Anmin Qi Mar. 1991 100 p
(Contract DE-AC03-76SF-00098)
(DE91-011868; LBL-30487) Avail: NTIS HC/MF A05

Three-dimensional vortex filament methods for unbounded, unsteady, inviscid, incompressible flow and a vortex tube stretching simulation with the vortex filament methods are studied in this thesis. We try to understand vortex tube stretching from the study of wave propagation along a vortex tube by the self-induced

velocity. Vortex filament methods are a proper numerical tool for this study. Therefore, we will focus our attention on vortex filament methods. The effects of numerical parameters, the choices of core functions, and numerical methods for solving the time evolution ordinary differential equation on accuracy and stability of the vortex filament methods are investigated in order to distinguish physical vortex stretching from the stretching caused by numerical instability. We also examine the conserved quantities such as kinetic energy, linear impulse, and total vorticity for various numerical parameters, core functions, and time integration methods. DOE

N91-25379# GEOMET Technologies, Inc., Germantown, MD.
COOLING PERFORMANCE EVALUATION OF A HIGH-EFFICIENCY VARIABLE-SPEED ELECTRIC HEAT PUMP IN A CONTEMPORARY RESEARCH HOUSE Topical Report, Jul. - Sep. 1989
N. L. Nagda, A. K. Trehan, and R. C. Fortmann Dec. 1990 92 p
(Contract GRI-5086-245-1265)
(PB91-159574; GEOMET-IE-2201; GRI-90/0272) Avail: NTIS HC/MF A05 CSCL 20D

A 2.5RT high-efficiency variable speed electric heat pump was tested during the cooling season in an unoccupied contemporary research house located near Washington, D.C. The house was moderately furnished to approximate conditions of occupancy for a family of three. The presence of occupants and the use of appliances were simulated. Performance of the unit was evaluated on the basis of indoor comfort, dynamic response to changing indoor/outdoor conditions, and energy consumption. Author

N91-25380* National Aeronautics and Space Administration. Pasadena Office, CA.
FLUID-LOOP REACTION SYSTEM Patent
Boris J. Lurie, inventor (to NASA), J. Alan Schier, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.), and Theodore C. Iskenderian, inventor (to NASA) 25 Jun. 1991 12 p Filed 31 Jan. 1990 Supersedes N90-26292 (28 - 20, p 2864)
(Contract NAS7-918)
(NASA-Case-NPO-17204-1-CU; US-Patent-5,026,008; US-Patent-Appl-SN-473242; US-Patent-Class-244-164; US-Patent-Class-244-165; US-Patent-Class-114-122; US-Patent-Class-114-125; Int-Patent-Class-B64G-1/28) Avail: US Patent and Trademark Office CSCL 20D

An improved fluid actuating system for imparting motion to a body such as a spacecraft is disclosed. The fluid actuating system consists of a fluid mass that may be controllably accelerated through at least one fluid path whereby an opposite acceleration is experienced by the spacecraft. For full control of the spacecraft's orientation, the system would include a plurality of fluid paths. The fluid paths may be circular or irregular, and the fluid paths may be located on the interior or exterior of the spacecraft.
Official Gazette of the U.S. Patent and Trademark Office

N91-25932*# District of Columbia Univ., Washington, DC. Dept. of Mechanical Engineering.
THE TRANSIENT PERFORMANCE OF A TWO-PHASE FLUID RESERVOIR Abstract Only
Joseph Chi *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 30 (For primary document see N91-25914 17-82) Avail: NTIS HC/MF A04 CSCL 20D

35 INSTRUMENTATION AND PHOTOGRAPHY

Includes remote sensors; measuring instruments and gages; detectors; cameras and photographic supplies; and holography.

For aerial photography see *43 Earth Resources and Remote Sensing.* For related information see also *06 Aircraft Instrumentation,* and *19 Spacecraft Instrumentation.*

N91-25381*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FIBER-OPTIC SENSORS FOR AEROSPACE ELECTRICAL MEASUREMENTS: AN UPDATE
Richard L. Patterson, A. H. Rose, D. Tang, and G. W. Day (National Inst. of Standards and Technology, Boulder, CO.) 1991 6 p Presented at the 26th Intersociety Energy Conversion Engineering Conference, Boston, MA, 4-9 Aug. 1991; sponsored by American Nuclear Society, SAE, American Chemical Society, AIAA, ASME, IEEE, and the American Inst. of Chemical Engineers
(NASA-TM-104454; E-6295; NAS 1.15:104454) Avail: NTIS HC/MF A02 CSCL 14B

Fiber-optic sensors are being developed for electrical current, voltage, and power measurements in aerospace applications. These sensors are presently designed to cover ac frequencies from 60 Hz to 20 kHz. The current sensor, based on the Faraday effect in optical fiber, is in advanced development after some initial testing. Concentration is on packaging methods and ways to maintain consistent sensitivity with changes in temperature. The voltage sensor, utilizing the Pockels effect in a crystal, has excelled in temperature tests. This paper reports on the development of these sensors, the results of evaluation, improvements now in progress, and the future direction of the work. Author

N91-25382*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PARTICLE IMAGE VELOCIMETRY FOR THE SURFACE TENSION DRIVEN CONVECTION EXPERIMENT USING A PARTICLE DISPLACEMENT TRACKING TECHNIQUE
Mark P. Wernet and Alexander D. Pline 1991 13 p Presented at the Fourth International Conference on Laser Anemometry, Cleveland, OH, 5-9 Aug. 1991; sponsored by ASME, European Association for Laser Anemometry, Case Western Reserve Univ., Cleveland State Univ., and the Ohio Aerospace Inst.
(NASA-TM-104482; E-6327; NAS 1.15:104482) Avail: NTIS HC/MF A03 CSCL 14B

The Surface Tension Driven Convection Experiment (STDCE) is a Space Transportation System flight experiment to study both transient and steady thermocapillary fluid flows aboard the USML-1 Spacelab mission planned for 1992. One of the components of data collected during the experiment is a video record of the flow field. This qualitative data is then quantified using an all electronic, two-dimensional particle image velocimetry technique called particle displacement tracking (PDT) which uses a simple space domain particle tracking algorithm. The PDT system is successful in producing velocity vector fields from the raw video data. Application of the PDT technique to a sample data set yielded 1606 vectors in 30 seconds of processing time. A bottom viewing optical arrangement is used to image the illuminated plane, which causes keystone distortion in the final recorded image. A coordinate transformation was incorporated into the system software to correct this viewing angle distortion. PDT processing produced 1.8 percent false identifications, due to random particle locations. A highly successful routine for removing the false identifications was also incorporated, reducing the number of false identifications to 0.2 percent. Author

N91-25383# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
CAMERA PLACEMENT IN INTEGER LATTICES (EXTENDED ABSTRACT)
Michel Pocchiola (Ecole Normale Superieure, Paris, France) and Evangelos Kranakis Sep. 1990 15 p Sponsored by Netherlands

Organization for the Advancement of Research
(CWI-CS-R9047; ETN-91-99377) Copyright Avail: NTIS HC/MF A03

Techniques for studying an art gallery problem (the camera placement problem) in the infinite lattice (L sup d) of d tuples of integers are considered. A lattice point A is visible from a camera C positioned at a vertex of (L sup d) if A does not equal C and if the line segment joining A and C crosses no other lattice vertex. By using a combination of probabilistic, combinatorial optimization and algorithmic techniques the position they must occupy in the lattice (L sup d) in the order to maximize their visibility can be determined in polynomial time, for any given number s less than or equal to (5 sup d) of cameras. This improves previous results for s less than or equal to (3 sup d). ESA

N91-25384# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.).
RADIOMETRIC NOISE IN DIGITIZED PHOTOGRAPHS
Hermann Diehl 1990 10 p
(MBB-Z-0170-90-Pub; ETN-91-99447) Avail: NTIS HC/MF A02

The effects of the graininess of the photographic emulsion on the radiometric noise of the digital data are investigated, particularly the degradation of the precision of point matching in stereo pairs. For small pixel sizes, e.g., 7.5 microns in the new Zeiss digitizer, the radiometric noise due to graininess can amount to more than 20 percent of signal. In contrast to that, the radiometric noise of a directly rasterizing charge coupled device camera is usually only a few thousands of the signal. ESA

N91-25385# Lawrence Livermore National Lab., CA.
SUB 100-PSEC X RAY GATING CAMERAS FOR ICF IMAGING APPLICATIONS
J. D. Kilkenny, P. M. Bell, B. A. Hammel, R. Hanks, O. Landen, T. McEwan, D. S. Montgomery, R. E. Turner, J. D. Wiedwald, and D. K. Bradley (Rochester Univ., NY.) 20 Aug. 1990 21 p Presented at the 19th International Congress on High Speed Photography and Photonics, Cambridge, England, 16-22 Sep. 1990
(Contract W-7405-eng-48)
(DE91-011202; UCRL-JC-106065; CONF-9009248-6) Avail: NTIS HC/MF A03

In this paper we report on several of the technical advances made at LLNL in the gating of MCP x ray detectors over the past two years, and show typical results obtained from implosions. The essential features of a gated microchannelplate (MCP) detector are discussed in this paper. A pulsed voltage (typically 1 kV, 100 psec) is applied across a MCP. The voltage is applied by gold conducting layers on the MCP, which form a microstrip line with the glass of the MCP. The voltage is applied by gold conducting layers on the MCP, which form a microstrip line with the glass of the MCP being the dielectric. While the voltage is applied the photo electrons resulting from x ray photons incident on the coated surface of the MCP are amplified with typically 10(exp 3) gain. Because the gain is non-linear with the applied voltage, (subject to consideration on the electron transit line in the MCP, Section 4) there can be narrowing of the optical gate with respect to the electrical gate. This relaxes the pulse voltage requirement for the MCP, to FWHM approximately 100 psec, and voltages of typically 1 kV into typically 25W. In Section 2 we discuss the novel approach we use for the generation of the electrical pulses required for the gated MCP cameras. The spatial resolution and the factors affecting it are described in Section 3. We discuss the temporal resolution of the MCP detectors in Section 4, and in Section 5 we discuss the configuration of microstrip coating on MCP detectors we have used and some typical results from laser driven implosions. Off line tests showing ultra font gating are described in Section 6. DOE

N91-25386# Oak Ridge National Lab., TN.
VARIABLE VOLUME CALIBRATION APPARATUS Patent
R. L. Hallman, Jr., inventor (to DOE) 1991 22 p
(Contract DE-AC05-84OR-21400)
(DE91-011554; Patents-US-A7471342) Avail: US Patent and Trademark Office

An apparatus is provided for determining the volume of a closed chamber. The apparatus includes a body having a cylindrical cavity therein including a threaded rear portion and a closed front end, and a piston having a threaded portion which mates with threaded rear portion of the cavity and which reciprocates in the cavity. A gas-impermeable seal, which is carried by the piston in one embodiment, forms a closed chamber in the front end of the cavity. A linear-movement indicator, attached to the rear end of the piston, measures the reciprocating movement of the piston in the cavity, while a pressure sensing device, connected to the front end of the cavity, determines the pressure in the closed system. In use, a vessel, having a volume enclosing experimental materials, is also connected to the front end of the cavity, and pressure and piston movement measurements are made which enable calculation of a volume change in the vessels. The design and operation of this instrument are presented. DOE

N91-25387*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PARTICLE DISPLACEMENT TRACKING APPLIED TO AIR FLOWS
Mark P. Wernet 1991 11 p Presented at the Fourth International Conference on Laser Anemometry, Cleveland, OH, 5-9 Aug. 1991; sponsored by NASA Lewis Research Center, ASME, European Association for Laser Anemometry, Case Western Reserve Univ., Cleveland State Univ. and the Oh
(NASA-TM-104481; E-6329; NAS 1.15:104481) Avail: NTIS HC/MF A03 CSCL 14B

Electronic Particle Image Velocimeter (PIV) techniques offer many advantages over conventional photographic PIV methods such as fast turn around times and simplified data reduction. A new all electronic PIV technique was developed which can measure high speed gas velocities. The Particle Displacement Tracking (PDT) technique employs a single cw laser, small seed particles (1 micron), and a single intensified, gated CCD array frame camera to provide a simple and fast method of obtaining two-dimensional velocity vector maps with unambiguous direction determination. Use of a single CCD camera eliminates registration difficulties encountered when multiple cameras are used to obtain velocity magnitude and direction information. An 80386 PC equipped with a large memory buffer frame-grabber board provides all of the data acquisition and data reduction operations. No array processors of other numerical processing hardware are required. Full video resolution (640x480 pixel) is maintained in the acquired images, providing high resolution video frames of the recorded particle images. The time between data acquisition to display of the velocity vector map is less than 40 sec. The new electronic PDT technique is demonstrated on an air nozzle flow with velocities less than 150 m/s. Author

N91-25388*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
RADIATION SENSITIVE AREA DETECTION DEVICE AND METHOD Patent Application
Daniel C. Carter, inventor (to NASA), Diana L. Hecht, inventor (to NASA), and William K. Witherow, inventor (to NASA) 3 Jun. 1991 24 p
(NASA-Case-MFS-28563-1; NAS 1.71:MFS-28563-1;
US-Patent-Appl-SN-710193) Avail: NTIS HC/MF A03 CSCL 14B

A radiation sensitive area detection device for use in conjunction with an X ray, ultraviolet or other radiation source is provided which comprises a phosphor containing film which releases a stored diffraction pattern image in response to incoming light or other electromagnetic wave. A light source such as a helium-neon laser, an optical fiber capable of directing light from the laser source onto the phosphor film and also capable of channelling the fluoresced light from the phosphor film to an integrating sphere which directs the light to a signal processing means including a light receiving means such as a photomultiplier tube. The signal processing means allows translation of the fluoresced light in order to detect the original pattern caused by the diffraction of the radiation by the original sample. The optical

fiber is retained directly in front of the phosphor screen by a thin metal holder which moves up and down across the phosphor screen and which features a replaceable pinhole which allows easy adjustment of the resolution of the light projected onto the phosphor film. The device produces near real time images with high spatial resolution and without the distortion that accompanies prior art devices employing photomultiplier tubes. A method is also provided for carrying out radiation area detection using the device of the invention. NASA

36 LASERS AND MASERS

Includes parametric amplifiers.
For related information see also *76 Solid-State Physics.*

N91-25389# Lawrence Livermore National Lab., CA.
ION YIELDS FROM STRONG OPTICAL FIELD IONIZATION EXPERIMENTS USING 100 FEMTOSECOND LASER PULSES
D. N. Fittinghoff, P. R. Bolton, B. Chang, L. D. VanWoerkom, and W. E. White 24 Jan. 1991 9 p Presented at the OE/LASE 1991: 4th Society of Photo-Optical Instrumentation Engineers (SPIE) International Symposium, Los Angeles, 20-25 Jan. 1991
(Contract W-7405-eng-48)
(DE91-011200; UCRL-JC-106962; CONF-910123-23) Avail: NTIS HC/MF A02

The ultra-fast ionization of argon, krypton and xenon by intense ultra-short laser pulses is studied. Intensities in the range 10(exp 14) to 10(exp 16) W/sq cm at a wavelength of 616 nm are provided by a colliding pulse mode-locked dye laser system. To date, ion yields have been monitored using a 1 meter time-of-flight spectrometer. Intensity dependent photoelectron signals are deduced from ion data. In an ultra-fast strong field environment, ionization times can be less than an optical period, affording a better distinction between a field ionization picture and a multiphoton ionization picture. For most cases that were studied, Keldysh parameters are below 1, indicating that it is a field ionization regime. As a laser system under development progresses towards the design goal of 1 joule per 100 femtosecond pulse, these investigations are extended to peak intensities of order 10(exp 18) to 10(exp 19) Watts/sq cm. DOE

N91-25390# Lawrence Livermore National Lab., CA.
MODELING OF LARGE APERTURE THIRD HARMONIC FREQUENCY CONVERSION OF HIGH POWER Nd:GLASS LASER SYSTEMS
M. A. Henesian, P. J. Wegner, D. R. Speck, C. Bibeau, R. B. Ehrlich, C. W. Laumann, J. K. Lawson, and T. L. Weiland 13 Mar. 1991 16 p Presented at the OE/LASE 1991: 4th Society of Photo-Optical Instrumentation Engineers (SPIE) International Symposium, Los Angeles, 20-25 Jan. 1991
(Contract W-7405-eng-48)
(DE91-011524; UCRL-JC-104439; CONF-910123-26) Avail: NTIS HC/MF A03

To provide high-energy, high-power beams at short wavelengths for inertial confinement fusion experiments, we routinely convert the 1.053-(mu)m output of the Nova, Nd:phosphate-glass, laser system to its third-harmonic wavelength. We describe performance and conversion efficiency modeling of the 3 (times) 3 arrays of potassium-dihydrogen-phosphate crystal plates used for type II/type II phase-matched harmonic conversion of Nova 0.74-m diameter beams, and an alternate type I/type II phase-matching configuration that improves the third-harmonic conversion efficiency. These arrays provide energy conversion of up to 65 percent and intensity conversion to 70 percent. DOE

N91-25391# EG and G Energy Measurements, Inc., Goleta, CA.
UNIFORM FIELD LASER ILLUMINATOR FOR REMOTE SENSING
J. DiBenedetto, G. Capelle, and S. Lutz 1991 20 p Presented at the SPIE International Symposium on Optical Engineering and Photonics in Aerospace Sensing, Orlando, 1-5 Apr. 1991
(Contract DE-AC08-88NV-10617)
(DE91-010823; EGG-10617-2079; CONF-910450-6) Avail: NTIS HC/MF A03

A novel method for achieving well behaved far field laser illumination of remote targets for imaging from an airborne platform is described. An assembly based on a mixing rod modifies the laser output to give uniform illumination of a remote target; further, the laser footprint on target can be closely matched to the detector field of view. Polarization is maintained through the assembly, and power losses are slight. Laboratory test performance is presented for both a dye laser and an excimer laser system. DOE

N91-25392*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SYNCHRONOUS STROBE APPARATUS FOR FLOW VISUALIZATION Patent Application
John M. Franke, inventor (to NASA), Stephen B. Jones, inventor (to NASA), Bradley D. Leighty, inventor (to NASA), and David B. Rhodes, inventor (to NASA) 6 May 1991 22 p
(NASA-Case-LAR-14556-1; NAS 1.71:LAR-14556-1; US-Patent-Appl-SN-699289) Avail: NTIS HC/MF A03 CSCL 20E

The present invention relates generally to flow visualization and, more specifically, to a strobed laser light curtain used for wind tunnel testing of rotating bodies. A laser produces a continuous beam which is strobed by a Bragg cell. The strobed beam is converted into a laser light curtain by an optics package. A synchronizing circuit provides an output signal to a Bragg cell driver which is coupled to the Bragg cell. The synchronizing circuit allows the user to set the pulsed duration of the strobe, the number of strobes per revolution, and the delay. The invention is particularly useful in wind tunnel testing of rotating blades, but could also be used for measuring other periodic motions. NASA

N91-25759*# Smithsonian Astrophysical Observatory, Cambridge, MA.
STATE OF THE ART AND FUTURE DIRECTIONS FOR THE ATOMIC HYDROGEN MASER
Robert F. C. Vessot *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 29-51 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20E

N91-25777*# Sigma Tau Standards Corp., Tuscaloosa, AL.
HYDROGEN MASERS WITH CAVITY FREQUENCY SWITCHING SERVOS
Harry E. Peters, H. B. Owings, and Paul A. Koppang *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 283-292 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20E

N91-25796*# Smithsonian Astrophysical Observatory, Cambridge, MA.
PHYSICS OF SYSTEMATIC FREQUENCY VARIATIONS IN HYDROGEN MASERS
Edward M. Mattison *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 453-464 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20E

N91-25799*# Quartz Research and Production Association, Gorky (USSR).
PERFORMANCE OF SOVIET AND US HYDROGEN MASERS
Adolph A. Uljanov, Nikolai A. Demidov, Edward M. Mattison, Robert F. C. Vessot, David W. Allan, and Gernot M. R. Winkler (Naval Observatory, Washington, DC.) *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 509-523 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20E

N91-25806*# Observatoire Cantonal, Neuchatel (Switzerland).
ON THE LINE Q DEGRADATION IN HYDROGEN MASERS
L. G. Bernier, Giovanni Busca, and Hartmut S. Schweda *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 599-606 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20E

37 MECHANICAL ENGINEERING

Includes auxiliary systems (nonpower); machine elements and processes; and mechanical equipment.

N91-25393# National Inst. of Standards and Technology, Gaithersburg, MD. Robot Systems Div.
SHORT-TERM EVOLUTION FOR THE FLIGHT TELEROBOTIC SERVICER
R. Lumia Dec. 1990 61 p
(PB91-144352; NISTIR-4463) Avail: NTIS HC/MF A04 CSCL 13I

Near term technology developments which would have significant impact on the evolution of the Flight Telerobotic Servicer (FTS) toward autonomous operation are identified. Analysis of anticipated FTS tasks is used to identify operations that might be performed autonomously, rather than in a purely teleoperated fashion. Alternative techniques for automating these operations are described. A discussion of FTS long-term evolution is included. Author

N91-25394# Southwest Research Inst., San Antonio, TX.
GAS ENGINE DURABILITY IMPROVEMENT, VOLUME 1 Final Report, Oct. 1985 - Sep. 1989
R. J. Mathis, R. W. Burrahm, S. Ariga, and R. D. Brown Aug. 1990 274 p
(Contract GRI-5085-293-1179)
(PB91-136341; SwRI-8868; GRI-90/0049.1) Avail: NTIS HC/MF A12 CSCL 13I

A need to improve the durability of natural gas-fueled engines by eliminating or reducing exhaust valve and valve seat recession is addressed. A literature search was conducted and discussions were held with natural gas-fueled engine users, maintenance shops, engine manufactures, and valve seat insert manufacturers to review the historical treatment of valve wear. Engines equipped with various types of valve seat inserts were used as test beds to obtain data relevant to recession, to compare the recession characteristics of various insert materials, and to determine the influence of engine operating conditions on recession. Instrumentation was selected to monitor realtime valve recession, valve insert temperatures, and cylinder pressure. Each set of valves, inserts, valve guides, and springs were dimensionally recorded before and after testing. Each exhaust valve and insert was visually inspected after the test and selected components were examined using metallurgical techniques. The influence of valve and cylinder head design, operating conditions, and material characteristics are discussed. GRA

N91-25395*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ANALYTICAL AND EXPERIMENTAL STUDY OF VIBRATIONS IN A GEAR TRANSMISSION
F. K. Choy, Y. F. Ruan, J. J. Zakrajsek, Fred B. Oswald, and J. J. Coy 1991 21 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; sponsored by AIAA, SAE, ASME, and the American Society for Electrical Engineers
(DA Proj. 1L1-62211-A-47A)
(NASA-TM-104434; E-6144; NAS 1.15:104434; AVSCOM-TR-90-C-032; AIAA-91-2019) Avail: NTIS HC/MF A03 CSCL 13I

An analytical simulation of the dynamics of a gear transmission system is presented and compared to experimental results from a gear noise test rig at the NASA Lewis Research Center. The analytical procedure developed couples the dynamic behaviors of the rotor-bearing-gear system with the response of the gearbox structure. The modal synthesis method is used in solving the overall dynamics of the system. Locally each rotor-gear stage is modeled as an individual rotor-bearing system using the matrix transfer technique. The dynamics of each individual rotor are coupled with other rotor stages through the nonlinear gear mesh forces and with the gearbox structure through bearing support systems. The modal characteristics of the gearbox structure are evaluated using the finite element procedure. A variable time steping integration routine is used to calculate the overall time transient behavior of the system in modal coordinates. The global dynamic behavior of the system is expressed in a generalized coordinate system. Transient and steady state vibrations of the gearbox system are presented in the time and frequency domains. The vibration characteristics of a simple single mesh gear noise test rig is modeled. The numerical simulations are compared to experimental data measured under typical operating conditions. The comparison of system natural frequencies, peak vibration amplitudes, and gear mesh frequencies are generally in good agreement. Author

N91-25396 Stanford Univ., CA.
EXPERIMENTS IN THRUSTERLESS ROBOT LOCOMOTION CONTROL FOR SPACE APPLICATIONS Ph.D. Thesis
Warren Joseph Jasper 1990 109 p
Avail: Univ. Microfilms Order No. DA9108845

While performing complex assembly tasks or moving about in space, a space robot should minimize the amount of propellant consumed. Space robot locomotion and orientation without the use of thrusters was studied analytically and experimentally. The goal was to design a robust control paradigm that performs thrusterless locomotion between two points on a structure, and to implement this paradigm on an experimental robot. A two-armed free-flying robot was constructed which floats on a cushion of air to simulate in two dimensions the drag-free zero-g environment of space. The controller design consists of two parts: a high-level strategic controller and a low-level dynamic controller. The strategic controller, implemented as a finite-state machine, monitors the state of the system and switches control laws asynchronously, based on discrete events. The dynamic controller consists of a system of estimators, control laws, trajectory generators, and filters. The control paradigm was verified experimentally by commanding the robot to push off from a structure with both arms, rotate 180 degrees while translating freely, and then catch itself on another structure. This method, based on the idea of computed torque, provides a linear feedback law in momentum and its derivatives for a system of rigid bodies. By controlling momentum, a configuration-independent quantity, the robot can leap precisely from one place to another, while accounting for nonlinear forces and changing kinematic constraints. It is believed that this design approach can be easily extended to three dimensions and more complex robot configurations. Dissert. Abstr.

N91-25397 Stanford Univ., CA.
A STUDY OF IN-PARALLEL MANIPULATORS Ph.D. Thesis
Sunil Kumar Agrawal 1990 153 p
Avail: Univ. Microfilms Order No. DA9108776

A class of manipulator systems referred to as in-parallel manipulator systems is investigated. In these systems, an end-effector link is connected to a base link by two or more in-parallel series chains. A feature of an in-parallel system is that the links form closed kinematic loops, and this imposes constraints on the motion of the links of the chains. Not all joint variables in an in-parallel system can be independently specific, and this makes the theory of their design different from the theory for series chains. The topics covered include the following: (1) the joint motions that can be independently prescribed in order to uniquely define the velocity of every link in the system, and how the joints should be driven to produce the desired end-effector rates; (2) the joint motor torques that can keep the entire system in equilibrium when external forces and couples are applied on the end-effector; (3) the conditions that are necessary and sufficient to determine a set of minimum motors; (4) the conditions that are necessary for a reference point on the end-effector to be at the boundary of its

workspace; and (5) the way to efficiently formulate the equations of motion of an in-parallel system when the equations of motion of the constituent series chains are available. A framework to study in-parallel systems is presented. This framework is based on instantaneous properties of series chains as derived from the theory of screw systems. In this framework, those screws which correspond to the joint actuators of the constituent series chains are identified. Once correspondence is made, the sought after actuator properties are deduced from the vector space properties of these screws. Author

N91-25398 Houston Univ., TX.
A GAUGE-THEORETICAL APPROACH TO MECHANICAL SYSTEMS Ph.D. Thesis
Michael Victor Csiszarik 1990 246 p
Avail: Univ. Microfilms Order No. DA9110815

A unifying gauge-theoretical approach for mechanical systems with a group configuration space was developed. The main goal is to represent motion in a form invariant with respect to arbitrary moving frames. The change of reference was identified with two types of gauge transformations. The equation of motion was derived by the variation of an Lagrangian on the group configuration space. The gauge-covariance of the equation of motion was demonstrated. A generalization to include dissipation was given. The equations of motion for several mechanical and hydrodynamic systems were derived and the advantages of the gauge-theoretical approach demonstrated. Mechanical systems for which the configuration space can be identified with a subgroup of the general linear group were considered. A gauge-covariant derivative was introduced, and gauge fields were defined as the difference between the derivatives associated with the motion and the (moving) reference frame. The gauge fields can be interpreted as a generalization of the usual relative velocity in classical mechanics. The gauge-theoretical treatment was generalized to include a class of dissipative systems with the help of a Rayleigh dissipation function. The equations of motion for several mechanical and hydrodynamic systems were realized as specializations of the same compact master equation: motion of a particle with and without potential, motion of a particle confined to a moving channel, rigid body motion with fixed point, rigid body motion in space, heavy top, motion of a rigid body through an ideal fluid (Kirchhoff equation), affinely rigid motion, motion of coupled rigid bodies, systems of hydrodynamic type, Lorenz system, moment model of vortex dynamics. In addition, the notion of a gauge transformation was applied to the point vortex model. Dissert. Abstr.

N91-25399 California Univ., Berkeley.
LEARNING CONTROL OF ROBOT MANIPULATORS Ph.D. Thesis
Wei-Wen Kao 1990 175 p
Avail: Univ. Microfilms Order No. DA9103746

A class of motion control algorithms for robot manipulators, called learning controllers, is discussed and implemented. These algorithms improve their performance in an iterative manner by learning from the tracking errors that resulted in previous attempts at executing a desired motion. The learning process involves the estimation of the feedforward control action, which is required to achieve perfect tracking, using parametric or functional adaptation algorithms. The application of a new functional identification and learning control algorithm to the repetitive control of robot manipulators is presented. A delayed version of the learning algorithm which can be implemented using conventional computers was also presented. A benchmark test was designed to compare the performance of the various learning control algorithms. Dissert. Abstr.

N91-25400# National Aerospace Lab., Tokyo (Japan).
AXIAL THRUST BALANCING OF SMALL HIGH-SPEED HIGH-PRESSURE ROCKET PUMPS
Takashi Shimura, Mitsuo Watanabe, and Satoshi Hasegawa Dec. 1990 15 p In JAPANESE; ENGLISH summary
(NAL-TR-1090; ISSN-0389-4010) Avail: NTIS HC/MF A03

Characteristics and feasibility of a self-balancing type axial thrust balancing system, referred to as balance piston, for high-pressure cryogenic rocket pumps were studied. Two small, high-speed, high-pressure rocket pumps which adapted the balance piston were tested under various operating conditions. One of the test pumps was a single-stage liquid oxygen pump with an inducer and the other was a two-stage liquid hydrogen pump with an inducer. Both pumps were driven by a dynamometer in the beginning, then they were driven by gas turbines in order to investigate the effects of the pump flow rate, flow rate through the balancing chamber, and the pump rotational speed on the balance piston characteristics. Transient characteristics of the balance piston were also investigated. As a result, it was concluded that the balance piston was able to adjust wide range of axial thrust change due to variation of operating conditions and was feasible for high-speed, high-pressure, cryogenic rocket pumps although special attention to transient characteristics was necessary. Author

N91-25401# Wichita State Univ., KS. National Inst. for Aviation Research.
DESIGN AND ANALYSIS SURFACE-CLIMBING ROBOT M.S. Thesis
Ziqiang Liu and Behnam Bahr Jun. 1991 127 p
(NIAR-91-19) Avail: NTIS HC/MF A07

The central concern of this research is the design and analysis of a surface-climbing robot which can walk not only on various kinds of surfaces, even on ceilings, but also on curved surfaces. It is also required that the robot carry inspection tools and communication devices. A reasonable kinematic and static analysis procedure is needed, so an optimal design is developed. Author

N91-25402# Technische Univ., Delft (Netherlands). Process Dynamics and Control Group.
DIGITAL OPTIMAL CONTROL OF RIGID MANIPULATORS Ph.D. Thesis
Louis Gerard vanWilligenburg 1991 292 p
(ISBN-90-6275-661-1; ETN-91-99429) Avail: NTIS HC/MF A13

In order to solve digital control problems they are generally approximated by discrete time problems. It is demonstrated that solving digital control problems without making any approximations allows for the design and use of digital robot controllers with large sampling times. This is important in the case of robot control where the computational burden on the computer is generally high. It is shown that by explicitly using the piecewise constant nature of digital control, the solution of the nonlinear optimal control problem (determination of robot motion as a function of time) can be simplified. The time optimal control problem where the initial and final velocities of the robot links are prescribed and the objective is to realize the transitions in minimum time, given bounds on the control variables, is solved for three types of robot motion control problems. The time optimal path tracking problem is solved. These two problems assumed a continuous time control. A tracking problem where the link positions are specified as a function of time is solved. The solution is in feedback form, and even for robots with a large number of degrees of freedom, it is suitable for implementation in relatively simple, slow computers. ESA

N91-25403# Argonne National Lab., IL.
THE RELATION OF HERTZIAN CONTACT PRESSURE TO FRICTION BEHAVIOR OF SELF-LUBRICATING BORIC ACID FILMS
A. Erdemir, R. A. Erck, and J. Robles (California Univ., Davis.) Feb. 1991 16 p Presented at the International Conference on Metallurgical Coatings and Thin Films, San Diego, 22-26 Apr. 1991
(Contract W-31-109-eng-38)
(DE91-010592; ANL/CP-72642; CONF-9104187-2) Avail: NTIS HC/MF A03

The effect of Hertzian contact pressure on the friction coefficient of self-lubricating boric acid (H3BO3) films was investigated by sliding steel and ceramic balls against boric oxide (B2O3) coated steel and ceramic disks under a wide range of contact loads. Self-lubricating H3BO3 films result from a spontaneous chemical reaction between water molecules and B2O3 coatings in humid

air. Mean initial Hertzian contact pressures in the range of 0.3 to 1.6 GPa, were created between balls and B2O3-coated disks by varying applied load and the radius of balls. It was demonstrated that an inverse relation exist between friction coefficient and Hertzian contact pressure. Using the Hertzian contact model, the shear strength of H3BO3 films was estimated to be approx. 22.9 MPa, which is comparable to that of MoS2, reported as 24.8 MPa. DOE

N91-25404# Texas A&M Univ., College Station. Center for Tectonophysics.
MECHANICAL PROPERTIES AND MODELING OF SEAL-FORMING LITHOLOGIES
A. K. Kronenberg, J. E. Russell, N. L. Carter, R. Mazariegos, and W. T. Shea Mar. 1991 60 p
(Contract DE-FG05-87ER-13711)
(DE91-010741; DOE/ER-13711/4) Avail: NTIS HC/MF A04

The goal was to evaluate the roles of deformation and the occurrence of weak sedimentary lithologies subjected to gravitational loads in shaping conventional and unconventional oil and gas reservoirs. Two sedimentary lithologies that influence the geometries, physical properties, and heterogeneities of oil and gas reservoirs are shale and rocksalt. Both form effect barriers to the flow and communication of petroleum and gas and, in many cases, form the seals to major reservoirs due to their low permeabilities. Both are actively deformed in depositional environments due to their low strengths relative to gravitational loads applied. Thus, the shapes of seal-forming units, and the nature of fractures and faults that may breach them depend upon either the mechanical properties of shale or those of salt, and the loading histories to which they have been subjected. Deformed shales may, in addition, serve as unconventional reservoirs of gas if open fractures within them provide sufficient porosity. The fracture and flow properties of shales are not well constrained, and the authors are currently investigating these properties experimentally. The rheology of rocksalt, on the other hand, is well known and they believe that the time is right to apply the experimentally constrained constitutive relations for rocksalt to deformations in the Earth. Efforts are continuing on modeling fracture anisotropy and the authors have examined simple, two-mica models to evaluate the mechanical interactions they proposed for gneiss and mica-poor schists. Brief summaries of the progress and results to date for (1) the mechanical properties of schist, (2) a two-mica model of fracture anisotropy, (3) deformation of shale, and (4) modeling of salt and shale tectonics of the northern Gulf of Mexico are given in the following sections. DOE

N91-25405# Argonne National Lab., IL.
DOE-OTM TRIBOLOGY PROGRAM Quarterly Progress Report, Jul. - Sep. 1990
F. A. Nichols, ed. and A. I. Michaels, ed. Jan. 1991 189 p
(Contract W-31-109-eng-38)
(DE91-010995; ANL/OTM-90/1) Avail: NTIS HC/MF A09

Under the current Annual Operating Plan (AOP) the tribology project is structured to conform with the ongoing and planned research activities into three program elements: Extreme Environment Lubrication: Experimental and theoretical (modeling) investigations of lubrication phenomena and the development of improved or novel lubricants, lubricant delivery systems and surface lubrication films, coatings and implants, for current and advanced engine systems. Engineered Tribological Interfaces: Research and development on ion beam and other coating processes to modify the microstructure and chemical composition of near surface regions in order to improve their friction and wear properties for use in advanced engine designs. Tribology by Design: Triboscience investigation of the microstructure of materials and lubricating surface layers in determining friction and wear: tribomaterials evaluation of the friction and wear behavior of newly emerging materials, particularly those promising low friction and wear at elevated temperatures in advanced engine designs; and tribocomponents evaluation which focuses on development of models, analysis/design tools to enable U.S. transportation industry to employ a tribology-by-design approach and dissemination of program developments to U.S. transportation industry. DOE

N91-25406# Oak Ridge National Lab., TN.
A NEW WHEEL CONTROL SYSTEM FOR THE OMNIDIRECTIONAL HERMIES-3 ROBOT
D. B. Reister Apr. 1991 33 p
(Contract DE-AC05-84OR-21400)
(DE91-011517; ORNL/TM-11784; CESAR-91/04) Avail: NTIS HC/MF A03

We have designed, built, and tested a new wheel control system for the HERMIES-III robot. HERMIES-III is a large mobile robot with omnidirectional steering that is designed for human scale experiments. During each cycle (at 20 Hz), the wheel control system moves the robot toward a goal and calculates the current position of the robot. The system has seven modes for moving to a goal and the goal may be changed during motion of the robot. DOE

N91-25407# Oak Ridge National Lab., TN.
USE OF FORCE-MEASURING TRANSDUCERS IN MANIPULATOR CONTROL. PART 2: IMPLEMENTATION
R. L. Kress and J. F. Jansen 1991 16 p Presented at the 1991 Society for Experimental Mechanics Spring Conference, Milwaukee, 9-13 Jun. 1991
(Contract DE-AC05-84OR-21400)
(DE91-010773; CONF-9106131-4-Pt-2) Avail: NTIS HC/MF A03

This paper investigates two types of control structures for mechanical manipulators using force-measuring transducers with each type targeting specific properties of the manipulator. One approach is to measure torque in the drive train of the manipulator to increase backdrivability, sensitivity, and stiffness. The second approach is to measure the forces and torques at the wrist of the manipulator. This force/torque vector is then used in a stiffness control algorithm which resolves dissimilar kinematics and increases sensitivity. Experiments with the Laboratory Telerobotic Manipulator (LTM) designed and built at Oak Ridge National Laboratory (ORNL) show how drive-train torque feedback can reduce the apparent friction in a manipulator drive train resulting from friction in gear boxes, bearings, and transmission components. For robotic operation, drive-train torque feedback can yield a significantly stiffer drive train. For teleoperated systems, drive-train torque feedback translates into improved backdrivability, better sensitivity, and improved stiffness. A 6-axis, wrist-mounted force-torque sensor was used in a Cartesian stiffness control algorithm implemented on the Center for Engineering Systems Advanced Research Manipulator (CESARm) located at ORNL. DOE

N91-25408# Argonne National Lab., IL.
THE POTENTIAL ROLE OF MAGLEV IN SHORT-HAUL AIRLINE OPERATIONS
L. R. Johnson 1991 6 p Presented at the Electro International Conference and Exhibition, New York, 16-18 Apr. 1991
(Contract W-31-109-eng-38)
(DE91-010813; ANL/CP-72295; CONF-9104211-1) Avail: NTIS HC/MF A02

Intercity travel is predominately by commercial air transport. However, airports are becoming increasingly congested at a time when there is often substantial local opposition to the expansion of airport infrastructure because of the environmental impacts. This paper explores the potential for integrating high-speed maglev systems into the airport infrastructure, but more importantly into airline operations. DOE

N91-25409# Argonne National Lab., IL.
COMBINED SOLID AND LIQUID LUBRICATION OF SILICON NITRIDE UNDER BOUNDARY CONDITIONS
O. O. Ajayi, A. Erdemir, J. H. Hsieh, R. A. Erck, and G. R. Fenske Feb. 1991 32 p Presented at the Society of Tribologists and Lubrication Engineers (STLE) Conference, Montreal (Canada), 29 Apr. - 2 May 1991
(Contract W-31-109-eng-38)
(DE91-011164; ANL/CP-72667; CONF-910478-2) Avail: NTIS HC/MF A03

In spite of their prospects for tribological applications, the high friction and wear of ceramic materials under dry sliding contact necessitate the need for lubrication. Results of the present study showed that an effective way of lubricating ceramic surfaces under boundary conditions at room and high temperatures was the simultaneous application of solid (soft metal) and liquid lubricants (oil). Compared to dry sliding of uncoated materials, oil lubricated sliding of ion beam assisted deposition (IBAD) Ag coated Si3N4 surface resulted (for the conditions tested) in a decrease of the friction coefficient by a factor of 18 (0.8 to 0.05) and of the wear rate by more than four orders of magnitude approx 10(exp -4) to approx 10(exp -8) cu mmN(exp -1)m(exp -1). The Ag coating was effective in preventing ceramic-to-ceramic contact under boundary lubricated regimes. The only drawback observed in the present study was the occurrence of a chemical interaction between the Ag film and sulfur from the oil which reduced the durability of the Ag film. DOE

N91-25410# Sandia National Labs., Albuquerque, NM.
PENETRATION IN METAL TARGETS: A NUMERICAL AND EXPERIMENTAL STUDY OF THE METAL-TACK FASTENER APPLIED TO HIGH STRENGTH STEELS
E. L. Hoffman Feb. 1991 32 p
(Contract DE-AC04-76DP-00789)
(DE91-011256; SAND-90-2433) Avail: NTIS HC/MF A03

A dynamic finite element analysis was performed to study the penetration mechanics of a commercial fastener called Metal-Tack(reg. sign). This study evaluated the fastener and identified parametric changes required for attachment to AISI 1070 steel (R(sub c) = 26), a material harder than the fastener was designed for. A set of baseline calculations was performed to evaluate the fastener's performance in yellow brass, a much softer material. The analysis indicated that a driving energy of 3.03 ft x lbs was required to drive the tack into yellow brass. Excellent correlation of this model with experimental data provided confidence for applying the model to AISI 1070 steel. Tack performance was investigated with respect to variations in driving energy and tack strength. The results demonstrated that increasing driving energy was not sufficient for a successful attachment in the steel. An increase in tack strength was also required. Higher tack strength was obtained by increasing the heat treat specification of the tack material, Carpenter R.D.S. steel, to obtain a hardness of R(sub c) = 60. With this increase in strength and a driving energy of 20.8 ft x lb, the results indicated that the tack would attach but develop high plastic strain (21.5 percent) during attachment. The calculations were confirmed with tests using a high energy pyrotechnic driver developed to attach the tack. Finally, a geometry modification intended to reduce stress concentrations in the tack was evaluated experimentally but not computationally. The experimental results indicated an improvement in the tack strength and attachment quality. DOE

N91-25411*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ACOUSTICAL ANALYSIS OF GEAR HOUSING VIBRATION
A. F. Seybert, T. W. Wu, X. F. Wu (Kentucky Univ., Lexington.), and Fred B. Oswald Apr. 1991 10 p Presented at the American Helicopter Society Technical Specialists Meeting, Philadelphia, PA, 15-16 Oct. 1991 Original contains color illustrations
(DA Proj. 1L1-62209-A-47A)
(NASA-TM-103691; E-5910; NAS 1.15:103691;
AVSCOM-TR-90-C-002) Avail: NTIS HC/MF A02; 1 functional color page CSCL 13I

The modal and acoustical analysis of the NASA gear-noise rig is described. Experimental modal analysis techniques were used to determine the modes of vibration of the transmission housing. The resulting modal data were then used in a boundary element method (BEM) analysis to calculate the sound pressure and sound intensity on the surface of the housing as well as the radiation efficiency of each mode. The radiation efficiencies of the transmission housing modes are compared with theoretical results for finite, baffled plates. A method that uses the measured mode shapes and the BEM to predict the effect of simple structural changes on the sound radiation efficiency of the modes of vibration is also described. Author

N91-25412*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ADVANCED ROTORCRAFT TRANSMISSION (ART) PROGRAM-BOEING HELICOPTERS STATUS REPORT
Joseph W. Lenski, Jr. (Boeing Helicopter Co., Philadelphia, PA.) and Mark J. Valco 1991 26 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; sponsored by AIAA, SAE, ASME, and the American Society for Electrical Engineers
(DA Proj. 1L1-62099-AH-76)
(NASA-TM-104474; E-6321; NAS 1.15:104474;
AVSCOM-TR-91-C-032) Avail: NTIS HC/MF A03 CSCL 13I

The Advanced Rotorcraft Transmission (ART) program is structured to incorporate key emerging material and component technologies into an advanced rotorcraft transmission with the intention of making significant improvements in the state of the art (SOA). Specific objectives of ART are: (1) Reduce transmission weight by 25 pct.; (2) Reduce transmission noise by 10 dB; and (3) Improve transmission life and reliability, while extending Mean Time Between Removal to 5000 hr. Boeing selected a transmission sized for the Tactical Tilt Rotor (TTR) aircraft which meets the Future Air Attack Vehicle (FAVV) requirements. Component development testing will be conducted to evaluate the high risk concepts prior to finalizing the advanced transmission configuration. The results of tradeoff studies and development test which were completed are summarized. Author

N91-25413*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
MAGNETIC BEARINGS-STATE OF THE ART
David P. Fleming Jul. 1991 27 p Submitted for publication
(NASA-TM-104465; E-6309; NAS 1.15:104465) Avail: NTIS HC/MF A03 CSCL 13K

Magnetic bearings have existed for many years, at least in theory. Earnshaw's theorem, formulated in 1842, concerns stability of magnetic suspensions, and states that not all axes of a bearing can be stable without some means of active control. In Beam's widely referenced experiments, a tiny (1/64 in diameter) rotor was rotated to the astonishing speed of 800,000 rps while it was suspended in a magnetic field. Despite a long history, magnetic bearings have only begun to see practical application since about 1980. The development that finally made magnetic bearings practical was solid state electronics, enabling power supplies and controls to be reduced in size to where they are now comparable in volume to the bearings themselves. An attempt is made to document the current (1991) state of the art of magnetic bearings. The referenced papers are large drawn from two conferences publications published in 1988 and 1990 respectively. Author

N91-25414# Japan Atomic Energy Research Inst., Tokyo.
A MODELLING OF ROBOT MANIPULATOR DYNAMICS BASED ON NEWTON-EULER'S EQUATIONS
Shinobu Sasaki Sep. 1990 45 p In JAPANESE; ENGLISH summary
(DE91-772107; JAERI-M-90-147) Avail: NTIS HC/MF A03

In this paper is presented an algorithm for solving the inverse dynamics of robot manipulators. In comparison with the dynamical equations derived from the Lagrange's mechanics, the relations to be treated are of simple form due to recursive expressions of relative link motions. A computer simulation for applying the algorithm to a six-link manipulator indicated that the present method might be most appropriate among the existing approaches from the viewpoint of computational efficiency. In particular, it is noted that the increase of the number of links has hardly great effect on the intricacy of calculation. DOE

N91-25415*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
PRESSURE VESSEL FLEX JOINT Patent Application

Jon Kahn, inventor (to NASA) 19 Feb. 1991 23 p
(NASA-Case-MSC-21748-1; NAS 1.71:MSC-21748-1;
US-Patent-Appl-SN-657598) Avail: NTIS HC/MF A03 CSCL 13K

An airtight, flexible joint is disclosed for the interfacing of two pressure vessels such as between the Space Station docking tunnel and the Space Shuttle Orbiter bulkhead adapter. The joint provides for flexibility while still retaining a structural link between the two vessels required due to the loading created by the internal/external pressure differential. The joint design provides for limiting the axial load carried across the joint to a specific value, a function returned in the Orbiter/Station tunnel interface. The flex joint comprises a floating structural segment which is permanently attached to one of the pressure vessels through the use of an inflatable seal. The geometric configuration of the joint causes the tension between the vessels created by the internal gas pressure to compress the inflatable seal. The inflation pressure of the seal is kept at a value above the internal/external pressure differential of the vessels in order to maintain a controlled distance between the floating segment and pressure vessel. The inflatable seal consists of either a hollow torus-shaped flexible bladder or two rolling convoluted diaphragm seals which may be reinforced by a system of straps or fabric anchored to the hard structures. The joint acts as a flexible link to allow both angular motion and lateral displacement while it still contains the internal pressure and holds the axial tension between the vessels. NASA

N91-25930*# George Washington Univ., Washington, DC. Dept. of Electrical Engineering and Computer Science.
DIGITAL REDESIGN OF THE CONTROL SYSTEM FOR THE ROBOTICS RESEARCH CORPORATION MODEL K-1607 ROBOT Abstract Only
Robert L. Carroll *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 28 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 13I

38 QUALITY ASSURANCE AND RELIABILITY

Includes product sampling procedures and techniques; and quality control.

N91-25416*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
QUALITY IMPROVEMENT PROTOTYPE: JOHNSON SPACE CENTER, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION Final Report
1990 26 p
(NASA-TM-104953; NAS 1.15:104953; PB91-153809) Avail: NTIS HC/MF A03 CSCL 14D

The Johnson Space Flight Center was recognized by the Office of Management and Budget as a model for its high standards of quality. Included are an executive summary of the center's activities, an organizational overview, techniques for improving quality, the status of the quality effort and a listing of key personnel. Author

N91-25417# Edgerton, Germeshausen and Grier, Inc., Idaho Falls, ID.
IMPROVING ADP QUALITY AND PRODUCTIVITY
1991 42 p Presented at the Association for Energy Systems Operations and Programming (AESOP) Conference on Improving ADP Quality and Productivity, Las Vegas, 16-18 Jan. 1991
(Contract DE-AC07-76ID-01570)
(DE91-010049; CONF-910155-Absts) Avail: NTIS HC/MF A03

A brief synopsis of each speakers comments at each session of the conference is included. Subjects covered are specific cases of organizational experiences in computer management. Topics addressed include the following: quality management in a Professional Services Group; computer security incident management; implementation of a quality improvement plan with an examination of metrics; management of maintenance activities; measuring software quality; improving productivity and quality through automated systems and networking; use of personal computers; distributed processing systems; computer graphics for scientific uses; management of information and data base systems; and artificial intelligence in computer programming. DOE

39 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; and thermal stress.

For applications see *05 Aircraft Design, Testing and Performance* and *18 Spacecraft Design, Testing and Performance.*

N91-25418# Illinois Univ., Urbana-Champaign. Dept. of Civil Engineering.
PARAMETER ESTIMATION IN COMPLEX LINEAR STRUCTURES
Keith D. Hjelmstad, Sharon L. Wood, and Stephen J. Clark Dec. 1990 151 p
(Contract DAAL03-87-K-0006; NSF CES-86-58019)
(PB91-151076; UILU-ENG-90-2015; ISSN-0069-4274) Avail: NTIS HC/MF A08 CSCL 20K

An approach to parameter estimation of complex linear structures, the mutual residual energy approach, is discussed. The goal was to develop a unified approach to the discrete inverse problems describing static equilibrium and free, undamped vibration, with a particular view toward evolving methods which are amenable to large-scale computation. The mutual residual energy method is based on the assumption that the topology and geometry of the structure are known, and that the system matrices can be linear parameterized in terms of kernel matrices which have a solid physical basis and are easy to assemble. Measured motions of the structure are used to make estimates of the constitutive parameters. The method is based on a particular statement of the principle of virtual work and yields equations for estimating stiffness and mass parameters of linear structures. If the response of the structure is measured completely, the estimation equations are linear and generally overdetermined. A condensation procedure is presented to deal with the case of incompletely measured systems. The quantity and quality of response measurements required, the consequences of noisy data, and the choice of load form are among the issues important to the success of the parameter estimation scheme. Extensive numerical simulations were carried out to assess the performance of the algorithms developed. GRA

N91-25419# Texas A&M Univ., College Station.
ELASTIC-PLASTIC FRACTURE MECHANICS: MARINE STRUCTURAL APPLICATIONS, PART 2
T. L. Anderson Apr. 1990 93 p Sponsored in part by the Ship Structure Committee, Washington, and by Coast Guard, Washington
(Contract DTCG23-88-C-20037)
(PB91-146043; SSC-345-Pt-2) Avail: NTIS HC/MF A05 CSCL 20K

The document contains the results of experimental and analytical studies of fracture in the ductile-brittle transition zone for two ship steels, EH36 and HSLA80. Tensile, Charpy and fracture toughness test results using different strain rates are presented. Fracture toughness was quantified by the J integral and the crack tip opening displacement (CTOD). Elastic-plastic finite element analysis was combined with a local failure criterion to derive size limits for J and CTOD testing in the transition regions. Relationships between J and CTOD were explored both experimentally and analytically. A theoretical Charpy-fracture toughness relationship was used to predict CTOD transition curves for the steels. Charpy and CTOD transition temperatures were compared for a number of steels. GRA

N91-25420# Sydney Univ. (Australia). School of Civil and Mining Engineering.
T-JOINTS IN RECTANGULAR HOLLOW SECTIONS SUBJECT TO COMBINED BENDING AND CONCENTRATED FORCE
X. L. Zhao and G. J. Hancock Mar. 1990 41 p
(PB91-137463; R-616) Avail: NTIS HC/MF A03 CSCL 13K

An extensive test program on a range of cold formed rectangular and square hollow sections subjected to combined bending and concentrated force is described. The concentrated force was applied by welding a square hollow section (called the branch member) to the center of the member under test (called the chord member) and perpendicular to it. The chord member was simply supported with concentrated force at the center of the span. The span was varied in order to determine the interaction relationship between bending moment and concentrated force. Tests under pure moment and pure concentrated force were performed for control purposes. The results are compared with the design procedures in the AISI-1986 Specification, Australian Standard AS1538-1988, the CIDECT Monograph No. 6 and other proposed procedures. In addition, a comparison with plastic mechanism models is provided. GRA

N91-25421*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
IMAT GRAPHICS MANUAL
Alan E. Stockwell (Lockheed Engineering and Sciences Co., Hampton, VA.) and Paul A. Cooper May 1991 73 p
(NASA-TM-104080; NAS 1.15:104080) Avail: NTIS HC/MF A04 CSCL 20K

The Integrated Multidisciplinary Analysis Tool (IMAT) consists of a menu driven executive system coupled with a relational database which links commercial structures, structural dynamics and control codes. The IMAT graphics system, a key element of the software, provides a common interface for storing, retrieving, and displaying graphical information. The IMAT Graphics Manual shows users of commercial analysis codes (MATRIXx, MSC/NASTRAN and I-DEAS) how to use the IMAT graphics system to obtain high quality graphical output using familiar plotting procedures. The manual explains the key features of the IMAT graphics system, illustrates their use with simple step-by-step examples, and provides a reference for users who wish to take advantage of the flexibility of the software to customize their own applications. Author

N91-25422*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
COMBINED COMPRESSIVE AND SHEAR BUCKLING ANALYSIS OF HYPERSONIC AIRCRAFT STRUCTURAL SANDWICH PANELS
William L. Ko and Raymond H. Jackson Washington May 1991 38 p
(NASA-TM-4290; H-1694; NAS 1.15:4290) Avail: NTIS HC/MF A03 CSCL 20K

The combined-load (compression and shear) buckling equations were established for orthotropic sandwich panels by using the Rayleigh-Ritz method to minimize the panel total potential energy. The resulting combined-load buckling equations were used to generate buckling interaction curves for super-plastically-formed/diffusion-bonded titanium truss-core sandwich panels and titanium honeycomb-core sandwich panels having the same specific weight. The relative combined-load buckling strengths of these two types of sandwich panels are compared with consideration of their sandwich orientations. For square and nearly square panels of both types, the combined load always induces symmetric buckling. As the panel aspect ratios increase, antisymmetric buckling will show up when the loading is shear-dominated combined loading. The square panel (either type) has the highest combined buckling strength, but the combined load buckling strength drops sharply as the panel aspect ratio increases. For square panels, the truss-core sandwich panel has higher compression-dominated combined load buckling strength. However, for shear dominated loading, the square honeycomb-core sandwich panel has higher shear-dominated combined load buckling strength. Author

N91-25423 Stanford Univ., CA.
APPLICATION OF THE STROH FORMALISM TO SELECTED STATIC AND DYNAMIC PROBLEMS IN TWO-DIMENSIONAL ANISOTROPIC ELASTICITY Ph.D. Thesis
Marun Joseph Abbudi 1990 192 p
Avail: Univ. Microfilms Order No. DA9108775

The Stroh formalism for two-dimensional anisotropic linear elasticity is used to solve different classes of problems of contemporary interest. A model problem capable of explaining the observation of stable void lattices in neutron irradiated anisotropic materials is formulated. It is solved numerically using a general-purpose boundary integral equation code for anisotropic materials, and states of strain energy minima are found for specific void spacing to void radius ratios. The problem of an infinitely long straight dislocation embedded in a thin layer over a semi-infinite substrate is formulated and solved, along with the similar problem of a dislocation in a semi-infinite substrate near a surface layer and the problem of a dislocation in one of two layers on a semi-infinite substrate. The general case of dislocation line in an arbitrary layer of an N-layer over a semi-infinite substrate system is also formulated. Expressions for the Peach-Koehler forces on such a dislocation are derived. Specific layered configurations of importance in integrated circuit technology are used as examples. The last part of the dissertation involves dynamic problems of steady plane wave propagation in anisotropic crystals. The subjects investigated include: the visualization of the slowness surface of a crystal and its three-dimensional contour; and development of an efficient algorithm for computing limiting speeds in piezoelectric as well as non-peizoelectric crystals. The problem of the existence of subsonic interfacial waves in bonded piezoelectric half-planes is also investigated where a maximum of two waves are shown to exist, the second due to the piezoelectric coupling. Numerical results for bonded cadmium sulfide crystals are presented. Dissert. Abstr.

N91-25424 Surrey Univ., Guildford (England).
THE FATIGUE STRENGTH OF ELECTROPLATED COMPONENTS Ph.D. Thesis
J. E. Adlington 1990 319 p
Avail: Univ. Microfilms Order No. BRDX91671

Coatings are added to components to provide enhanced protection from the surroundings or to recondition them after the surfaces have been damaged. But the change in conditions at the surface will often lead to a change in the resistance to fatigue loading. This investigation is focused on the behavior of shouldered shafts electroplated with nickel, chromium, and cobalt/chromium carbide composite. Changes in fatigue strength are demonstrated. Each of the materials has a unique effect on the behavior of a shaft, although there is a similarity which can be utilized in design. Each can reduce the fatigue strength by a substantial amount, but it is possible to optimize the design of a new shaft so that its strength is not significantly different to that of an uncoated version. The composite coating has the least effect. Explanations for these effects are given, based on differences in the mechanical properties of the substrate and coating materials, the distribution of residual stresses within the materials, and the interaction of these factors with the applied stress profile. Recommendations and methods of analysis which can be used in the design of coated components are presented. The contribution of the manufacturing process is discussed, and grinding is highlighted as a dominant factor. Gentle grinding procedures are shown to produce ideal conditions by inducing large compressive residual stresses in the surfaces. Radial plots of the residual stresses were produced. These were obtained by techniques based on Sachs' method, using electrochemical machining, and an extended analysis developed for use with coated parts. The stress distributions were not affected by fatigue limit loading, indicating that stress relief methods using amplitudes of this order are ineffective and unsafe. Dissert. Abstr.

N91-25425 Lehigh Univ., Bethlehem, PA.
INTERFACE CRACK IN NONHOMOGENEOUS BONDED MATERIALS OF FINITE THICKNESS Ph.D. Thesis
Yaofeng Chen 1990 224 p
Avail: Univ. Microfilms Order No. DA9109563

In a recently developed material forming method called Functional Gradient Materials as well as applications of material deposition processes such as Ion Plating, composite materials are being created where the interface possesses a gradually varying material composition and properties. A crack in such an interface is studied, and parameters were sought that govern the crack growth such as the crack tip stress intensity factors, strain energy release rate and probable direction of crack extension. The mixed boundary value problem involved two materials of finite thickness with an interface crack to be formulated in plane strain or generalized plane stress. One material is homogeneous and the other nonhomogeneous with an exponential variation in the y-direction. The technique developed is useful for fracture mechanics study of composite materials that have a nonhomogeneous interface. The results compiled are especially well suited for thin film cases which is characteristic of the majority of applications intended. Dissert. Abstr.

N91-25426 Virginia Univ., Charlottesville.
A CLASSIFICATION OF GENERAL HELICOIDAL SHELLS Ph.D. Thesis
Michael Rohn England 1990 91 p
Avail: Univ. Microfilms Order No. DA9112021

A Euler angle/rotator decomposition based on the so-called xyz-scheme (Goldstein 1980) is presented. This scheme is unambiguous in that each axis of rotation remains distinct whether or not any other Euler angle vanishes. This makes the xyz-scheme better suited for linearizing the field equations. The static-geometric duality of Goldenveizer is derived for Simmonds' helicoidal shell theory under the xyz-scheme for Euler angles. The linearized equations of Simmonds' helicoidal shell theory that are based on the xyz-scheme are presented. A topological classification of helicoidal shells is defined. Based on Reimann connectivity, the assumption of material continuity, and smooth deformations, it is seen that helicoidal deformation is a class preserving operation, i.e., a helicoidal shell cannot be taken out of its class by a helicoidal deformation. Finally, one special category is identified: under a Kirchhoff assumption, it is shown that a shell of revolution undergoing axisymmetric bending and torsion can be described by four, first-order differential equations and two, algebraic equations. Dissert. Abstr.

N91-25427 Stanford Univ., CA.
ON HETEROGENIZATION IN ELASTICITY Ph.D. Thesis
Tanios Victor Honein 1990 141 p
Avail: Univ. Microfilms Order No. DA9108840

The analysis of the stress field of an elastic body, into which several inclusions have been inserted, is of significant importance both from the micromechanical and structural engineering points of view. Here, a novel approach, heterogenization, is proposed and implemented to carry out such an analysis. This novel procedure consists in expressing the solution of the heterogeneous problem in terms of that of the homogeneous one, i.e., the solution for the complete infinite body without inclusions and subjected to the same loading. This heterogenization procedure is based, for problems with circular or straight boundaries of the inclusions, on the involution correspondence, recently discovered by the author, which relates the problem of plane elastostatics for a circular disk to that of an infinite region with a circular hole, subjected either to the same tractions or same displacements along the common boundary. This allows one to express the solution of either problem, with singularities within the region, to that of the corresponding problem for the complete infinite region (subjected to the same singularities). This procedure is then extended to the case when, instead of a hole, a circular elastic inclusion is present. It is shown that the character of the solution is influenced radically by different boundary conditions. The heterogenization procedure is also applied to the case of circularly or plane layered media subjected to arbitrary loading and under antiplane or plane deformation. Dissert. Abstr.

N91-25428 Virginia Polytechnic Inst. and State Univ., Blacksburg.
MINIMUM-WEIGHT DESIGN OF SYMMETRICALLY LAMINATED COMPOSITE PLATES FOR POSTBUCKLING PERFORMANCE UNDER INPLANE COMPRESSION LOADS Ph.D. Thesis
Dong Ku Shin 1990 168 p
Avail: Univ. Microfilms Order No. DA9108067

A postbuckling analysis procedure for simply-supported, symmetrically laminated, rectangular, generally orthotropic plates under uniaxial compression based on a Marguerre-type energy method was developed. The analysis assumes the out-of-plane displacement to be represented by using a truncated Fourier sine series. The unknown coefficients of the displacement function were obtained from a system of nonlinear algebraic equations by using the principle of minimum potential energy. The number of terms that are to be retained in the out-of-plane displacement function to obtain an accurate response was studied and identified for a wide range of generally orthotropic plates. In the postbuckling load range, plates are also allowed to change their buckled form. The magnitudes of the total potential energy for possible different deformed shapes of a plate were compared to determine the actual deformed shape. The effect of bending-twisting coupling terms on the postbuckling behavior of anisotropic laminates was also investigated. Several postbuckling problems for isotropic, orthotropic, and anisotropic plates were considered and the results obtained by the present approach were compared with available literature results and finite element solutions to demonstrate the present analysis procedure. The analysis procedure developed was, then, applied to minimum-weight design of laminated plates for postbuckling performance. Laminate failure load used in the postbuckling regime was calculated based on a maximum strain failure criterion. Weight comparison between the plates designed against buckling and the ones designed for the postbuckling strength was made to quantitatively evaluate the weight savings achieved for plates that are allowed to buckle. Dissert. Abstr.

N91-25429 Lehigh Univ., Bethlehem, PA.
THE SURFACE AND THROUGH CRACK PROBLEMS IN LAYERED ORTHOTROPIC PLATES Ph.D. Thesis
Binghua Wu 1990 268 p
Avail: Univ. Microfilms Order No. DA9109588

The main objective of this study is to develop an analytical method for a relatively accurate calculation of Stress Intensity Factors in a laminated orthotropic plate containing a through or a part-through crack. The laminated plate is assumed to be under bending or membrane loading and the mode I problem is considered. First three transverse shear deformation plate theories (Mindlin's displacement based first-order theory, Reissner's stress-based first-order theory and a simple-higher order theory due to Reddy) are reviewed and examined for homogeneous, laminated and heterogeneous orthotropic plates. Then based on a general linear laminated plate theory, a method by which the stress intensity factors can be obtained in orthotropic laminated and heterogeneous plates with a through crack is developed. Examples are given for both symmetrically and unsymmetrically laminated plates and the effect of various material properties on the stress intensity factors are studied. In order to implement the line-spring model which is used later to study the surface crack problem, the corresponding plane elasticity problem of a two-bonded orthotropic plate containing a crack perpendicular to the interface is also considered. Three different crack profiles, an internal crack, an edge crack and a crack terminating at the interface are considered. The effect of the different material combinations, geometries and material orthotropy on the stress intensity factors and on the power of stress singularity for a crack terminating at the interface is fully examined. The Line Spring model of Rice and Levy is used for the part-through crack problem. Rather extensive numerical results are given for both laminated composite and bonded metal-ceramic structural materials with

various geometrical configurations. These results will be useful in brittle fracture analysis and more importantly, in subcritical crack growth studies. All problems considered in this study are of the mixed boundary value type and are reduced to Cauchy type of singular integral equations which are then solved numerically.
Dissert. Abstr.

N91-25430 Auburn Univ., AL.
DAMPING PHENOMENA IN A WIRE ROPE VIBRATION ISOLATION SYSTEM Ph.D. Thesis
Michael Loyd Tinker 1989 129 p
Avail: Univ. Microfilms Order No. DA9109144

A study of the dynamic characteristics of a wire rope vibration isolation system constructed with helical cable isolators is presented. Emphasis is placed on the analytical modeling of damping mechanisms in the system. An experimental investigation is performed in which the static stiffness curve, hysteresis curves, phase planes, and displacement frequency response curves are obtained. A semi-empirical model having nonlinear stiffness, nth-power velocity damping, and variable Coulomb friction damping is developed. A computer program is developed to iteratively determine the unknown coefficients in the equation of motion, and to solve it using the Runge-Kutta method. Results are compared to experimental data, and satisfactory agreement is obtained. The analytical model is found to have well-defined instability regions for some combinations of damping and stiffness parameters. Conclusions about dynamic phenomena in wire rope systems are made based on experimental and semi-empirical results. It is found that the wire rope system is nonlinear, and that the nonlinearities are due to variations in the friction forces among the cable wires. The cable geometry determines the shapes of the static stiffness curve, the hysteresis curves, and the phase planes. The damping energy consistently increases for increased excitation amplitude and varies with frequency in the same manner as the relative displacement. Dissert. Abstr.

N91-25431 Cincinnati Univ., OH.
FINITE ELEMENT ANALYSIS OF FRICTIONAL DAMPING FORCES IN STRUCTURAL JOINTS SUBJECTED TO FLEXURAL VIBRATION Ph.D. Thesis
Robert Stafford Ballinger 1990 163 p
Avail: Univ. Microfilms Order No. DA9108633

A major source of damping that occurs in a structure results from frictional damping forces and relative motion of the connected parts at a joint interface. A numerical finite element method for determining the frictional damping in high strength structural joints subjected to flexural vibration is presented. Elastostatic contact problems with friction form a class of problems that are load history dependent because of the non-conservative, irreversible nature of the frictional forces. In the analysis, the contacting bodies are coupled together using appropriate contact and friction conditions. Then, the use of substructuring is proposed to develop a governing system of equations. An iterative procedure is employed to solve the system of equations. Interations are chosen to select incremental load level, determine the total contact area at each load step, and determine the nonsliding portion of contact (due to friction) at each load step. The analysis first considers the dynamic response of the structural joint without interface friction. A normal modes analysis determines the natural frequencies and corresponding mode shapes of the structural joint without friction. Next, a scaled model vector is applied as an enforced displacement load in an incremental linear static load scaling analysis to determine the energy dissipated by friction in one load cycle. This frictional energy dissipation can be used to calculate an equivalent viscous damping coefficient and subsequently a linearized forced response calculation. Test/analysis correlation of an example structural joint is included. Dissert. Abstr.

N91-25432 Rensselaer Polytechnic Inst., Troy, NY.
MODELING OF TIME-DEPENDENT MECHANICAL DEFORMATION BEHAVIORS OF METALS AND ALLOYS USING VISCOPLASTICITY THEORY BASED ON OVERSTRESS Ph.D. Thesis
Seok Hwan Choi 1990 223 p
Avail: Univ. of Microfilms Order No. DA9111052

A previously developed orthotropic theory of viscoplasticity based on overstress (VBO) is specialized for cubic symmetry. The theory does not use yield surface and loading/unloading conditions. The three dimensional theory is specialized for uniaxial tests in cube side, face diagonal, and body diagonal directions. The theory predicts that circular cross sections of specimens tested in cube side and body diagonal directions deform into circles. In contrast, cross sections of specimens tested in face diagonal direction distort and the distortion can be calculated from the theory. The simple continuum theory needs two material functions and twelve constants to characterize the time-dependent behavior of single crystal superalloys. Short-term uniaxial creep, relaxation, and strain rate change behavior of a nickel based single crystal is modeled using the theory. Three different sets of constants are needed to simulate the tests. While each set simulates the steady state behavior quite well, differences exist in the transient behavior. Predictions for monotonic loadings in three different directions are given with assumed material constants based on one specific direction. Additionally an attempt for representing the tension/compression asymmetry is given. The orthotropic theory of VBO is expanded for the modeling of long-term behavior by including the effect of recovery of state. The inclusion of the recovery permits the modeling of long-term creep of single crystal superalloys. The influence of the static recovery on the short-term behavior is also investigated. Isotropic theory of VBO is used to model the cyclic hardening behavior of metals. The applicability of VBO to dynamic plasticity is investigated. Dissert. Abstr.

N91-25433 Stanford Univ., CA.
A GEOMETRICALLY EXACT SHELL THEORY Ph.D. Thesis
David Dean Fox 1990 266 p
Avail: Univ. Microfilms Order No. DA9108816

The mathematical foundation for and the mechanical analysis of a fully nonlinear, geometrically exact shell theory are provided. This formulation of the shell equations has the advantage that, although the exact nonlinear geometric structure of the idealized two-dimensional body is maintained, complex differential geometry concepts such as covariant derivatives, Riemannian connections or Christoffel symbols are avoided. Furthermore, a weak or variational statement of the local balance equations is developed that is ideally suited for numerical solution techniques. The analysis begins with a derivation of the integrated or resultant momentum balance equations governing the deformation of a three dimensional body. Next, the single director shell kinematic assumption is introduced. The single director shell assumption is the defining feature of the subsequent analysis. With this assumption, the complete kinematic description of the shell and the complete (finite) set of shell momentum balance equations are determined. For elastic material response, the shell resultant stored-energy function is derived and then defined in terms of the three-dimensional stored-energy function. The particular case of a compressible Mooney-Rivlin type material model is considered. A variational formulation of the shell equations is then developed. The weak form of the momentum balance equations is particularly important for the numerical implementation of the shell equations. Furthermore, the consistent tangent operator for the momentum balance equations is derived. The tangent operator is a vital component of the nonlinear iterative solution procedure and is required for such topics as bifurcation analysis. Dissert. Abstr.

N91-25434 Stanford Univ., CA.
INELASTICITY AND MIXED VARIATIONAL METHODS IN CLASSICAL CONTINUA AND GEOMETRICALLY EXACT SHELLS Ph.D. Thesis
John Gerard Kennedy 1990 295 p
Avail: Univ. Microfilms Order No. DA9108850

The continuum basis and numerical implementation of elastoplasticity coupled with mixed variational methods are developed within the context of both classical continua and resultant based shells. The theory is developed for both linear

and fully nonlinear kinematics and focuses specifically on the case in which the boundary of the elastic domain is defined by an arbitrary number of yield surfaces intersecting in a non-smooth fashion. Efficient, unconditionally stable return mapping algorithms are constructed to integrate the elastoplastic constitutive equations within a variety of displacement based and mixed finite element methods. The development begins with a thermodynamically based continuum theory of multi-yield-surface elastoplasticity and viscoplasticity for both classical continua and resultant based shells. The fundamental property of the continuum theory of multi-yield-surface elastoplasticity and viscoplasticity developed herein is that, given the free energy function and the yield function(s), the complete continuum elastoplastic theory, consisting of hyperelastic stress-strain equations, evolution equations for the plastic variables and Kuhn-Tucker loading/unloading conditions, evolves from two basic principles: the second law of thermodynamics and the principle of maximum entropy production. For resultant based shells, the continuum theory is formulated entirely in stress resultants. A resultant based shell model of importance, the classical ILYUSHIN-SHAPIRO model, is extended to accommodate physically meaningful notions of kinematic and isotropic hardening, and consistently formulated to accommodate finite deformation. For viscoplasticity, the DUVAUT-LIONS formulation is extended to accommodate hardening variables in the multi-surface regime. Dissert. Abstr.

N91-25435 Auburn Univ., AL.
AN ENERGY-BASED FRACTURE CRITERION FOR FIBER COMPOSITES Ph.D. Thesis
Shao Qin Zhang 1989 112 p
Avail: Univ. Microfilms Order No. DA9109165

An energy-based fracture hypothesis referred to as the Z criterion is proposed for orthotropic composite material structures. The theory predicts critical crack propagation conditions and the crack propagation direction. It is an extension of the well known strain energy density criterion (S criterion). The S criterion has been widely used and several prior investigations have indicated that it can be successfully applied to explain the cracking behavior of a homogeneous isotropic solid. However, no theory has been widely accepted for composite materials when they are modeled as a homogeneous anisotropic medium. The Z criterion extends earlier strain energy criteria and removes certain deficiencies by considering separately the dilatational and distortional strain energy density factors. For composite materials under mode one conditions, it suggests that crack initiation is controlled by the dilatational strain energy density factor. For mode two and mode three it is proposed that crack initiation is controlled by the distortional strain energy density factor. Mixed mode crack initiation is proposed to be controlled by a damage energy density factor (Z factor) which is the vector norm of the mode one, mode two, and mode three controlling parameters. Analytical equations are presented for the stress fields and strain energy density factors in off-axis unidirectional composite laminates subjected to mode one, mode two, and mode three conditions. The application of J-integral to the new criterion (Z criterion) is discussed. The new criterion is then evaluated for several composites in relatively simple configurations, and these results are compared to the predictions of other criteria. Dissert. Abstr.

N91-25436*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PROBABILITY OF FAILURE AND RISK ASSESSMENT OF PROPULSION STRUCTURAL COMPONENTS
Michael C. Shiao (Sverdrup Technology, Inc., Cleveland, OH.) and Christos C. Chamis 1989 10 p Presented at the 1989 Joint Army, Navy, NASA, Air Force Propulsion Meeting, Cleveland, OH, 23-25 May 1989 Previously announced as N90-18470
(NASA-TM-102323; E-5019; NAS 1.15:102323) Avail: NTIS HC/MF A02 CSCL 20K

Because of the increasing need to account for the uncertainties in material properties, loading conditions, geometry, etc., a methodology was developed to determine structural reliability and to assess the associated risk. The methodology consists of a probabilistic structural analysis by a probabilistic finite element computer code, numerical evaluation of stochastic structures under stress (NESSUS), and a generic probabilistic material property model. The methodology is versatile and is equally applicable to structures operating at high and cryogenic temperature environments. Results obtained demonstrate that the issues of structural reliability and risk can be formally evaluated by using the methodology developed which is inclusive of the uncertainties in material properties, structural parameters, and loading conditions. The methodology is described in some detail with illustrative examples. Author

N91-25437*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
IDENTIFICATION OF OBSERVER/KALMAN FILTER MARKOV PARAMETERS: THEORY AND EXPERIMENTS
Jer-Nan Juang, Minh Phan, Lucas G. Horta, and Richard W. Longman Jun. 1991 30 p Presented at the AIAA Guidance, Navigation, and Controls Conference, New Orleans, LA, 12-14 Aug. 1991
(NASA-TM-104069; NAS 1.15:104069) Avail: NTIS HC/MF A03 CSCL 20K

An algorithm to compute Markov parameters of an observer or Kalman filter from experimental input and output data is discussed. The Markov parameters can then be used for identification of a state space representation, with associated Kalman gain or observer gain, for the purpose of controller design. The algorithm is a non-recursive matrix version of two recursive algorithms developed in previous works for different purposes. The relationship between these other algorithms is developed. The new matrix formulation here gives insight into the existence and uniqueness of solutions of certain equations and gives bounds on the proper choice of observer order. It is shown that if one uses data containing noise, and seeks the fastest possible deterministic observer, the deadbeat observer, one instead obtains the Kalman filter, which is the fastest possible observer in the stochastic environment. Results are demonstrated in numerical studies and in experiments on an ten-bay truss structure. Author

N91-25438*# Yale Univ., New Haven, CT. Dept. of Mechanical Engineering.
ON REPRESENTATION OF MECHANICAL BEHAVIOR AND STEREOLOGICAL MEASURES OF MICROSTRUCTURE Final Report
E. T. Onat and S. I. Wright Jun. 1991 21 p
(Grant NAG3-834)
(NASA-CR-187130; NAS 1.26:187130) Avail: NTIS HC/MF A03 CSCL 20K

Macroscopic homogeneity of a heterogeneous body is defined from various points of view. The applicability of the principle of Delesse to a single macroscopically homogeneous body is discussed. It is then seen that a function derived from a consideration of the area fraction of a phase can serve as a measure of clustering of particles of that phase. Author

N91-25439# Technische Univ., Delft (Netherlands).
PHASE SHIFTING SPECKLE INTERFEROMETRY Ph.D. Thesis
Adrianus Antonius Ma Maas 1991 142 p Sponsored by Stichting voor Fundamenteel Onderzoek der Materie
(ETN-91-99425) Avail: NTIS HC/MF A07

The development of an interferometric measuring method and its application in the determination of mechanical properties of a solid object, like shape, deformation, and strain are described. Basic principles of holographic and speckle interferometry and methods for producing quantitative data from interference patterns are presented. The general theory of the phase shifting technique is outlined and statistics associated with the speckle phenomenon are reviewed. The phase shifting speckle interferometer used for experiments is described and measurement results for the displacement vector field and surface strain of loaded objects are given. Results on a T shaped object are compared with finite element method (FEM) predictions and an outlook for their combination is given. To optimize phase measuring accuracy,

speckles have to be made smaller than the optical resolution of the detector in the case of low object beam intensity. The comparison of FEM predictions shows good agreement for displacement and strain. A systematic deviation of 10 percent was observed and random discrepancies of up to 15 percent were deduced from the results. ESA

N91-25440# Technische Univ., Delft (Netherlands).
CONTROL OF CRACK WIDTH IN DEEP REINFORCED CONCRETE BEAMS Ph.D. Thesis
Cornelis Rene Braam 1991 110 p
(Grant STW-DCT66-1243)
(ISBN-90-9003853-1; ETN-91-99427) Copyright Avail: NTIS HC/MF A06

The cracking behavior of deep reinforced concrete beams is analyzed with attention focused on the amount of horizontal web reinforcement required to control the cracking in the web. A model to calculate steel stresses and crack spacing, which is also applicable to tensile members provided with reinforcement located at the side faces, is presented. For the latter type of elements a relation between the minimum reinforcement and the cracking behavior are reviewed and thick tensile members with reinforcement concentrated at two opposite side faces are discussed. Results from surveying calculations performed with the finite element program DIANA are presented and give close agreement with experimental observations presented. A 'beam model' specially suited for analysis of the overall structural behavior of deep beams is introduced. Results are presented by design curves for use in engineering practice. Examples of their use are explained in a reinforced T beam and a thick-tensile member with reinforcement placed at two opposite side faces. Both phenomena are defined by the behavior of the reinforced zones. ESA

N91-25441# Westinghouse Hanford Co., Richland, WA.
PRE-TEST ANALYSIS OF A PIPE SYSTEM FOR HIGH-LEVEL VIBRATION RESPONSE AND FAILURE
E. O. Weiner and L. K. Severud Mar. 1991 8 p Presented at the American Society of Mechanical Engineers (ASME) Pressure Vessels and Piping Conference, San Diego, 23-27 Jun. 1991
(Contract DE-AC06-87RL-10930)
(DE91-010835; WHC-SA-1016; CONF-910602-25) Avail: NTIS HC/MF A02

Simplified elastic and inelastic analyses for high level vibration response and cyclic failure capacity of a prototypic light water reactor pipe system were carried out in a pretest environment. The system consists of a steam generator and a circulating pump with associated piping that has been tested on a shake table. Five analyses, ranging from standard linear elastic to detailed inelastic transient analysis, are compared in terms of response. With the inelastic analysis, subsequent failure analysis indicated that strain in the 3 to 4 pct. range can be expected if the planned inputs are realized. Possible cyclic failure was predicted by through-wall cracking and leaking in 20 to 40 cycles of maximum strain range, caused by ratchet fatigue in the pressurized system. DOE

N91-25442*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FATIGUE LIFE PREDICTION OF AN INTERMETALLIC MATRIX COMPOSITE AT ELEVATED TEMPERATURES
Paul A. Bartolotta 1991 12 p Presented at the 1991 Winter Annual Meeting of ASME, Atlanta, GA, 1-6 Dec. 1991
(NASA-TM-104494; E-6352; NAS 1.15:104494) Avail: NTIS HC/MF A03 CSCL 20K

A strain-based fatigue life prediction method is proposed for an intermetallic matrix composite (IMC) under tensile cyclic loadings at elevated temperatures. Styled after the Universal Slopes method, the model utilizes the composite's tensile properties to estimate fatigue life. Factors such as fiber volume ratio, number of plys and temperature dependence are implicitly incorporated into the model through these properties. The model constants are determined by using unidirectional fatigue data at temperatures of 425 and 815 C. Fatigue lives from two independent sources are used to verify the model at temperatures of 650 and 760 C. Cross-ply lives at 760 C are also predicted. It is demonstrated that the correlation between experimental and predicted lives is within a factor of two. Author

N91-25443*# Washington Univ., Seattle. Dept. of Mechanical Engineering.
THERMOVISCOPLASTIC RESPONSE OF Ti-15-3 UNDER VARIOUS LOADING CONDITIONS
M. E. Tuttle and J. Rogacki Jun. 1991 125 p
(Grant NAG1-974)
(NASA-CR-188621; NAS 1.26:188621) Avail: NTIS HC/MF A06 CSCL 20K

The long term objective is to develop a combined experimental analytic methodology for predicting the thermoviscoplastic behavior of the neat (i.e., unreinforced) titanium matrix. Once a constitutive model which adequately describes the behavior of titanium has been identified, the viscoplastic behavior of unidirectional composites will be predicted through the use of the rule-of-mixtures. A crucial aspect of the study is the selection of a constitutive model to describe the thermoviscoplastic behavior of titanium. Author

42 GEOSCIENCES (GENERAL)

N91-25444*# National Aeronautics and Space Administration, Washington, DC.
FOURTH AIRBORNE GEOSCIENCE WORKSHOP: SUMMARY MINUTES
Feb. 1991 98 p Workshop held in La Jolla, CA, 29 Jan. - 1 Feb. 1991; sponsored by NASA, NOAA, NSF, NCAR, Geological Survey, ONR, and AFGL
(NASA-TM-104982; NAS 1.15:104982) Avail: NTIS HC/MF A05 CSCL 08B

The general theme for the workshop revolved around global environmental change. Over 170 individuals participated in the presentations and ensuing discussions about the many agency activities using airborne platforms and sensors in support of the U.S. Global Change Research Program (GCRP). The U.S. GCRP was developed as a central component of the U.S. Government's approach to global change and its contribution to worldwide efforts. An all-encompassing U.S. plan was developed by the Committee on Earth and Environmental Sciences (CEES), which continues as the interagency coordinating group for the program. The U.S. GCRP was established as a Presidential initiative in the FY90 budget, making it a particularly relevant topic for the workshop. The following are presented in the appendices: (1) final agenda and list of registrants; (2) final list of poster presenters; (3) steering group luncheon participants; (4) the draft resolution; and (5) selected handouts. Author

N91-25445*# National Aeronautics and Space Administration, Washington, DC.
FOURTH AIRBORNE GEOSCIENCE WORKSHOP
1991 278 p Workshop held in La Jolla, CA, 29 Jan. - 1 Feb. 1991; sponsored by NASA, NOAA, NSF, NCAR, Geological Survey, ONR, and AFGL
(NASA-TM-104983; NAS 1.15:104983) Avail: NTIS HC/MF A13 CSCL 08B

The focus of the workshop was on how the airborne community can assist in achieving the goals of the Global Change Research Program. The many activities that employ airborne platforms and sensors were discussed: platforms and instrument development; airborne oceanography; lidar research; SAR measurements; Doppler radar; laser measurements; cloud physics; airborne experiments; airborne microwave measurements; and airborne data collection. For individual titles, see N91-25446 through N91-25493.

N91-25446*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

AIRBORNE LIDAR RESEARCH Abstract Only c46

S. Harvey Melfi *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 43 (For primary document see N91-25445 17-42)

Avail: NTIS HC/MF A13 CSCL 04A

The planetary boundary layer (PBL) is the lowest layer of the atmosphere in contact with the Earth's surface. It plays an important role in atmospheric circulation and dynamics by influencing surface fluxes of moisture, heat, and momentum. The PBL is characterized by its turbulence structure. Organized convection within the PBL may generate gravity waves within the free troposphere. These waves can propagate vertically, modifying global circulation. Remote sensing of the PBL using a downward-looking lidar is providing new insight into dynamic processes of this important layer and its connection with wave generation. An airborne lidar is an ideal tool to study the PBL. The lidar is installed on the NASA Electra aircraft. It consists of a frequency doubled Nd:YAG laser aligned with a 40 cm diameter telescope. As the laser beam propagates downward from the aircraft toward the surface, it is scattered by the aerosols and molecules in the atmosphere. Generally, there is a sharp gradient of aerosol scattering associated with the PBL top, with high aerosol scattering from within the PBL, and generally very low scattering from the free atmosphere above. It is this gradient in aerosol scattering that is used to visualize the structure of the PBL. A small portion of the scattered radiation is collected by the telescope, filtered, detected by a photomultiplier, and digitized at 100 nsec rate. The horizontal resolution is typically around 13 m, using a 10 Hz laser and a nominal aircraft moves, the resolution of features in the atmosphere below the aircraft is about 15 x 13 m. Results from several studies are presented and discussed. Author

N91-25447*# National Aeronautics and Space Administration, Washington, DC.

NASA 1990 MULTISENSOR AIRBORNE CAMPAIGNS (MACS) FOR ECOSYSTEM AND WATERSHED STUDIES c46

Diane E. Wickland, Ghassem Asrar, and Robert E. Murphy *In its* 4th Airborne Geoscience Workshop 1991 p 71-72 (For primary document see N91-25445 17-42)

Avail: NTIS HC/MF A13 CSCL 08H

The Multisensor Airborne Campaign (MAC) focus within NASA's former Land Processes research program was conceived to achieve the following objectives: to acquire relatively complete, multisensor data sets for well-studied field sites, to add a strong remote sensing science component to ecology-, hydrology-, and geology-oriented field projects, to create a research environment that promotes strong interactions among scientists within the program, and to more efficiently utilize and compete for the NASA fleet of remote sensing aircraft. Four new MAC's were conducted in 1990: the Oregon Transect Ecosystem Research (OTTER) project along an east-west transect through central Oregon, the Forest Ecosystem Dynamics (FED) project at the Northern Experimental Forest in Howland, Maine, the MACHYDRO project in the Mahantango Creek watershed in central Pennsylvania, and the Walnut Gulch project near Tombstone, Arizona. The OTTER project is testing a model that estimates the major fluxes of carbon, nitrogen, and water through temperate coniferous forest ecosystems. The focus in the project is on short time-scale (days-year) variations in ecosystem function. The FED project is concerned with modeling vegetation changes of forest ecosystems using remotely sensed observations to extract biophysical properties of forest canopies. The focus in this project is on long time-scale (decades to millenia) changes in ecosystem structure. The MACHYDRO project is studying the role of soil moisture and its regulating effects on hydrologic processes. The focus of the study is to delineate soil moisture differences within a basin and their changes with respect to evapotranspiration, rainfall, and streamflow. The Walnut Gulch project is focused on the effects of soil moisture in the energy and water balance of arid and semiarid ecosystems and their feedbacks to the atmosphere via thermal forcing. Author

N91-25448*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

NASA/AMES RESEARCH CENTER'S SCIENCE AND APPLICATIONS AIRCRAFT PROGRAM Abstract Only c43

G. Warren Hall *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 79 (For primary document see N91-25445 17-42)

Avail: NTIS HC/MF A13 CSCL 05B

NASA-Ames Research Center operates a fleet of seven Science and Applications Aircraft, namely the C-141/Kuiper Airborne Observatory (KAO), DC-8, C-130, Lear Jet, and three ER-2s. These aircraft are used to satisfy two major objectives, each of equal importance. The first is to acquire remote and in-situ scientific data in astronomy, astrophysics, earth sciences, ocean processes, atmospheric physics, meteorology, materials processing and life sciences. The second major objective is to expedite the development of sensors and their attendant algorithms for ultimate use in space and to simulate from an aircraft, the data to be acquired from spaceborne sensors. NASA-Ames Science and Applications Aircraft are recognized as national and international facilities. They have performed and will continue to perform, operational missions from bases in the United States and worldwide. Historically, twice as many investigators have requested flight time than could be accommodated. This situation remains true today and is expected to increase in the years ahead. A major advantage of the existing fleet of aircraft is their ability to cover a large expanse of the earth's ecosystem from the surface to the lower stratosphere over large distances and time aloft. Their large payload capability allows a number of scientists to use multi-investigator sensor suites to permit simultaneous and complementary data gathering. In-flight changes to the sensors or data systems have greatly reduced the time required to optimize the development of new instruments. It is doubtful that spaceborne systems will ever totally replace the need for airborne science aircraft. The operations philosophy and capabilities exist at NASA-Ames Research Center. Author

N91-25449*# National Aeronautics and Space Administration. Wallops Flight Facility, Wallops Island, VA.

GOODARD SPACE FLIGHT CENTER/WALLOPS FLIGHT FACILITY AIRBORNE GEOSCIENCE SUPPORT CAPABILITY c43

Roger L. Navarro *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 81-83 (For primary document see N91-25445 17-42)

Avail: NTIS HC/MF A13 CSCL 05B

Goddard Space Flight Center's Wallops Facility (GSFC/WFF), operates six aircraft which are used as airborne geoscience platforms. The aircraft complement consists of two UH-1B helicopters, one twin engine Skyvan, one twin jet T-39, and two four engine turboprop aircraft (P-3 and Electra) offering the research community a wide range of payload, altitude, speed, and range capabilities. WFF's support to a principal investigator include mission planning of all supporting elements, installation of equipment on the aircraft, fabrication of brackets, and adapters as required to adapt payloads to the aircraft, and planning of mission profiles to meet science objectives. The flight regime includes local, regional, and global missions. The WFF aircraft serve scientists at GSFC, other NASA centers, other government agencies, and universities. The WFF mode of operation features the walk on method of conducting research projects. The principal investigator requests aircraft support by letter to WFF and after approval is granted, works with the assigned mission manager to plan all phases of project support. The instrumentation is installed in WFF electronics racks, mounted on the aircraft, the missions are flown, and the equipment is removed when the scientific objectives are met. The principal investigator reimburses WFF for each flight hours, any overtime and travel expenses generated by the project, and for other mission-related expenses such as aircraft support services required at deployment bases. Author

N91-25450*# Sterling Software, Moffett Field, CA.
THE PILOT LAND DATA SYSTEM (PLDS) AT THE AMES RESEARCH CENTER MANAGES AIRCRAFT DATA IN COLLABORATION WITH AN ECOSYSTEM RESEARCH PROJECT **c43**
Gary Angelici, Lidia Popovici, and Jay Skiles *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 93-95 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

The Pilot Land Data System (PLDS) is a data and information system serving NASA-supported investigators in the land science community. The three nodes of the PLDS, one each at the Ames Research Center (ARC), the Goddard Space Flight Center (GSFC) and the Jet Propulsion Laboratory (JPL), cooperate in providing consistent information describing the various data holding in the hardware and software (accessible via network and modem) that provide information about and access to PLDS-held data, which is available for distribution. A major new activity of the PLDS node at the Ames Research Center involves the interaction of the PLDS with an active NASA ecosystem science project, the Oregon Transect Ecosystems Research involves the management of, access to, and distribution of the large volume of widely-varying aircraft data collected by OTTER. The OTTER project, is managed by researchers at the Ames Research Center and Oregon State University. Its principal objective is to estimate major fluxes of carbon, nitrogen, and water of forest ecosystems using an ecosystem process model driven by remote sensing data. Ten researchers at NASA centers and universities are analyzing data for six sites along a temperature-moisture gradient across the western half of central Oregon (called the Oregon Transect). Sensors mounted on six different aircraft have acquired data over the Oregon Transect in support of the OTTER project. Author

N91-25451*# National Aeronautics and Space Administration. John C. Stennis Space Center, Bay Saint Louis, MS.
AIRCRAFT LASER DERIVED CHLOROPHYLL DISTRIBUTION ACROSS THE ICELAND-FAEROE FRONT Abstract Only **c43**
Robert A. Arnone and Paul E. LaViolette *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 97 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

The ocean surface color (water-leaving radiances) and thermal structure across the Iceland-Faeroe Front under both clear and cloudy conditions were measured from a NASA research aircraft on 25 May 1989. The measurements were made along four north-south lines that were 125 km in length and spaced 35 km apart. The color measurements were made with a 14 channel, non-polarized Multispectral Airborne Radiometer System (MARS) while the thermal data were collected by a thermal radiometer and aircraft bathythermographs. The satellite imagery (NOAA AVHRR) sequence show the development of meanders through the frontal region. These aircraft ocean color and thermal data characterize the biological distribution and are closely coupled to the physical processes occurring in the frontal systems. The ratio of several channels of the ocean color data are used to determine the surface chlorophyll. The retrieved data correlate well with laser-induced chlorophyll fluorescence obtained at the same time and historical chlorophyll data. The observed chlorophyll patchiness appearing across the Iceland-Faeroe Front is believed to be directly and indirectly related to primary and secondary circulation processes in ocean frontal systems. High chlorophyll concentrations were observed on the north side of the front and are inferred to be the result from the advection of Icelandic Coastal Water into the region. The sharp chlorophyll decline at and south of the thermal frontal boundary is clearly related to the subsurface thermal structure. Author

N91-25452*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
GLOBAL BACKSCATTER EXPERIMENT (GLOBE) PACIFIC SURVEY MISSION **c46**
David A. Bowdle, Jeffry Rothermel, James E. Arnold, and Steven F. Williams (Alabama Univ., Huntsville.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 107-110 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 04A

NASA conducted the GLObal Backscatter Experiment (GLOBE) Survey Mission over the near coastal and remote Pacific Ocean during 6 to 30 Nov. 1989 (GLOBE 1) and 13 May to 5 Jun. 1990 (GLOBE 2). These missions studied the optical, physical, and chemical properties of atmospheric aerosols. Particular emphasis was given to the magnitude and spatial variability of aerosol backscatter coefficients at mid-infrared wavelengths, and to the remote middle and upper troposphere, where these aerosol properties are poorly understood. Survey instruments were selected to provide either direct beta measurements at the key wavelengths, empirical links with long term or global scale aerosol climatologies, or aerosol microphysics data required to model any of these quantities. The survey deployment included both long distance 6 to 8 hour transit flights and detailed 4 to 6 hour local flights. Several general features were observed from preliminary Survey data analyses. Validation and intercomparison results have shown good agreement, usually better than a factor of two. Atmospheric aerosols frequently exhibited a three layer vertical structure, with (1) high and fairly uniform backscatter in the shallow cloud capped marine boundary layer; (2) moderate and highly variable backscatter in a deeper overlaying cloud pumped layer; and (3) low, regionally uniform, but seasonally and latitudinally variable backscatter in the middle and upper troposphere. The survey missions represent two isolated snapshots of a small portion of the global aerosol system. Consequently, Survey results can best be understood by synthesizing them with the more comprehensive GLOBE data base, which is being compiled at NASA-Marshall. Author

N91-25453*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
CALIBRATION OF THE ER-2 METEOROLOGICAL MEASUREMENT SYSTEM **c47**
Stuart W. Bowen (San Jose State Univ., CA.), K. Roland Chan, and T. Paul Bui *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 111-112 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 04B

The Meteorological Measurement System (MMS) on the high altitude ER-2 aircraft was developed specifically for atmospheric research. The MMS provides accurate measurements of pressure, temperature, wind vector, position (longitude, latitude, altitude), pitch, roll, heading, angle of attack, angle of sideslip, true airspeed, aircraft eastward velocity, northward velocity, vertical acceleration, and time, at a sample rate of 5/s. MMS data products are presented in the form of either 5 or 1 Hz time series. The 1 Hz data stream, generally used by ER-2 investigators, is obtained from the 5 Hz data stream by filtering and desampling. The method of measurement of the meteorological parameters is given and the results of their analyses are discussed. Author

N91-25454*# National Aeronautics and Space Administration. John C. Stennis Space Center, Bay Saint Louis, MS.
AIR DEPLOYED EXPENDABLE PROBES IN OCEANOGRAPHIC RESEARCH Abstract Only **c48**
Janice D. Boyd *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 113 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 08C

Physical oceanographic instrumentation is both nonexpendable and expendable. Expendable instruments for both shipboard and aircraft use were developed which yield moderate accuracy and precision at a low or moderate unit cost and which may be deployed by less trained personnel on less specialized platforms both in more extreme environmental conditions and while underway. While shipboard expendables are familiar to many researchers, most are not familiar with the variety of air deployable expendables available, although the quasi-synoptic, 3-D view of the ocean that aerial studies yield can be very valuable in oceanographic research. As well as acoustic oriented probes, air deployed sensors exist for the measurement of temperature, sound speed, currents, and

optical properties, and work is underway to develop probes measuring simultaneous conductivity and temperature. In addition, low cost drifting buoys with both oceanographic and meteorological sensors are available, and ice penetrating probes are being developed for arctic research. Characteristics of these instruments are presented, along with examples of their use and a discussion of some of their not so well publicized shortcomings. Author

N91-25455*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TROPOSPHERIC OZONE AND AEROSOLS MEASURED BY AIRBORNE LIDAR DURING THE 1988 ARCTIC BOUNDARY LAYER EXPERIMENT **c45**
Edward V. Browell, Carolyn F. Butler, and Susan A. Kooi (ST Systems Corp., Hampton, VA.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 119-120 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 13B

Ozone (O3) and aerosol distributions were measured from an aircraft using a differential absorption lidar (DIAL) system as part of the 1988 NASA Global Tropospheric Experiment - Arctic Boundary Layer Experiment (ABLE-3A) to study the sources and sinks of gases and aerosols over the tundra regions of Alaska during the summer. The tropospheric O3 budget over the Arctic was found to be strongly influenced by stratospheric intrusions. Regions of low aerosol scattering and enhanced O3 mixing ratios were usually correlated with descending air from the upper troposphere or lower stratosphere. Several cases of continental polar air masses were examined during the experiment. The aerosol scattering associated with these air masses was very low, and the atmospheric distribution of aerosols was quite homogeneous for those air masses that had been transported over the ice for greater than or = 3 days. The transition in O3 and aerosol distributions from tundra to marine conditions was examined several times. The aerosol data clearly show an abrupt change in aerosol scattering properties within the mixed layer from lower values over the tundra to generally higher values over the water. The distinct differences in the heights of the mixed layers in the two regions was also readily apparent. Several cases of enhanced O3 were observed during ABLE-3 in conjunction with enhanced aerosol scattering in layers in the free atmosphere. Examples are presented of the large scale variations of O3 and aerosols observed with the airborne lidar system from near the surface to above the tropopause over the Arctic during ABLE-3. Author

N91-25456*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AIRBORNE LIDAR MEASUREMENTS OF OZONE DURING THE 1989 AIRBORNE ARCTIC STRATOSPHERIC EXPEDITION **c45**
Edward V. Browell, Marta A. Fenn, and Susan A. Kooi (ST Systems Corp., Hampton, VA.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 121-122 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 13B

The NASA/NOAA Airborne Arctic Stratospheric Expedition (AASE) was conducted during the winter to study the conditions leading to possible ozone (O3) destruction in the wintertime Arctic stratosphere. As part of this experiment, the NASA-Langley airborne differential absorption lidar (DIAL) system was configured for operation on the NASA-Ames DS-8 aircraft to make measurements of O3 profiles from about 1 km above the aircraft to altitudes of 22 to 26 km. The airborne DIAL system remotely sensed O3 above the DC-8 by transmitting two laser beams at 10 Hz using wavelengths of 301.5 and 311 nm. Large scale distributions of O3 were obtained on 15 long range flights into the polar vortex during the AASE. Selected data samples are presented of O3 observed during these flights, general trends observed in O3 distributions, and correlations between these measurements and meteorological and chemical parameters. The O3 distribution observed on the first flight of the DC-8 into the polar vortex on Jan. 6 reflected the result of diabatic cooling of the air inside the vortex during the winter compared to the warmer air outside the vortex. On a potential temperature surface, the O3 mixing ratio generally increases when going from outside to inside the vortex. Author

N91-25457*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
APPLICATIONS OF THE ER-2 METEOROLOGICAL MEASUREMENT SYSTEM **c47**
K. Roland Chan, Leonhard Pfister, T. Paul Bui, Stuart W. Bowen, and Jonathan Dean-Day (San Jose State Univ., CA.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 125-126 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 04B

The NASA ER-2 aircraft is used as a platform for high altitude atmospheric missions. The Meteorological Measurement System (MMS) was developed specifically for atmospheric research to provide accurate high resolution measurements of pressure, temperature, and the 3-D wind vector with a sampling rate of 5/s. The MMS consist of three subsystems: (1) an air motion sensing system to measure the velocity of the air with respect to the aircraft; (2) a high resolution inertial navigation system (INS) to measure the velocity of the aircraft with respect to the earth; and (3) a data acquisition system to sample, process, and record the measurement quantities. MMS data have been used extensively by ER-2 investigators in elucidating the polar ozone chemistry. Herein, applications on atmospheric dynamics are emphasized. Large scale (polar vortex, potential vorticity, model atmosphere), mesoscale (gravity waves, mountain waves) and microscale (heat fluxes) atmospheric phenomena are investigated and discussed. Author

N91-25458*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
NASA/AMES RESEARCH CENTER DC-8 DATA SYSTEM **c61**
S. C. Cherniss (Sterling Software, Moffett Field, CA.) and C. P. Scofield *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 127-130 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 09B

In-flight facility data acquisition, distribution, and recording on the NASA Ames Research Center (ARC) DC-8 are performed by the Data Acquisition and Distribution System (DADS). Navigational and environmental data collected by the DADS are converted to engineering units and distributed real-time to investigator stations once per second. Selected engineering units data are printed and displayed on closed circuit television monitors throughout flights. An in-flight graphical display of the DC-8 flight track (with barbs indicating wind direction and magnitude) has recently been added to the DADS capabilities. Logging of data run starts/stops and commentary from the mission director are also provided. All data are recorded to hard disk in-flight and archived to tape medium post-flight. Post-flight, hard copies of the track map and mission director's log are created by the DADS. The DADS is a distributed system consisting of a data subsystem, an Avionic Serial Data-to-VMEbus (ASD2VME) subsystem, and a host subsystem. Each subsystem has a dedicated central processing unit (CPU) and is capable of stand-alone operation. All three subsystems are housed in a single 20-slot VME chassis and communicate with each other over the VMEbus. The data and host subsystems are briefly discussed, and the DC-8 DADS internal configuration and system block diagram are presented. Author

N91-25459*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
THE Cl-36 IN THE STRATOSPHERE **c45**
Bruce Deck, Martin Wahlen, Harley Weyer, Peter Kubik, Pankaj Sharma, and Harry Gove (Rochester Univ., NY.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 131-132 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 13B

Initial measurements of the cosmogenic radionuclide, Cl-36, in the lower stratosphere were made by accelerator mass spectrometry. Samples were obtained using the large volume LASL

air sampling pods on a NASA WB-57F aircraft. Untreated (for collection of particulates only) and tetrabutyl ammonium hydroxide treated (for collection of particulates and HCl) IPC-1478 filters were flown on three flights in the lower stratosphere. Chlorine (Cl) and Cl compounds are important trace constituents for stratospheric chemistry, in particular with respect to O3 destruction. Stratospheric Cl chemistry has recently received increased attention with the observation of strong O3 depletion in the Antarctic winter vortex and in the weaker and more complex Arctic winter vortices. Cosmogenic (Cl-36) is produced by spallation reactions from Ar mainly in the stratosphere, and has had several applications as a geochemical tracer. The large amounts of Cl-36 introduced by nuclear weapon testing have been removed from the stratosphere by now, and measurements in the stratosphere to obtain cosmogenic production rates and concentration distributions is now possible. The use of cosmogenic Cl-36 as a tracer for stratospheric Cl chemistry and for stratospheric/tropospheric exchange processes is investigated. A first attempt to determine stratospheric and tropospheric production rates, the partitioning of Cl-36 among particulate and gaseous Cl compounds, and the respective inventories and removal rates is being made. Results from a flight at 13.7 km, 30-33 degrees N, 97-107 degrees W, and from a second flight at 17.7 km, 43-45-36 degrees N, 92-94 degrees W, for the untreated and treated filters respectively are presented.
Author

N91-25460*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
NASA DC-8 AIRBORNE RESEARCH LABORATORY c43
Leo H. DeGreef *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 133-136 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

Since the summer of 1987, NASA Ames Research Center has been operating a DC-8 equipped with CFM 56 engines as a flying research laboratory. In this relatively short time, the DC-8, with its tremendous capabilities, has made significant contributions to numerous scientific fields. Capable of staying aloft for over 12 hours, the DC-8 has flown directly over both the North and South Poles, gathering data relating to the ozone hole. Operating from a few thousand feet to over 40,000 feet above sea level the interchangeable payload capability of the DC-8 has made it a versatile scientific tool. The DC-8 also plays a vital role in the development of new satellite-borne sensors as very often those sensors are test-flown on the DC-8 before they are launched into space. The tremendous range and instrument carrying capability make the DC-8 an ideal flying laboratory. A few of the programs the DC-8 has participated in as well as a sampling of the instruments carried are outlined.
Author

N91-25461*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
THE GEOLOGIC REMOTE SENSING FIELD EXPERIMENT (GRSFE): THE FIRST GEOLOGY MULTISENSOR AIRBORNE CAMPAIGN Abstract Only c43
Diane L. Evans and Raymond E. Arvidson (Washington Univ., Seattle.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 137 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

The primary objective of the Geologic Remote Sensing Field Experiment (GRSFE) is to acquire relevant data for geological sites that can be used to test models for extraction of surface property information from remote sensing data for earth, Mars and Venus in support of the Earth Observing System (EOS), Mars Observer, and Magellan, respectively. Over forty scientists from eight universities and three NASA centers are participating in GRSFE which is co-sponsored by the NASA Planetary Geology and Geophysics Program and the NASA Geology Program. Highlights of the airborne campaign included the first simultaneous acquisition of Airborne Visible and Infrared Imaging Spectrometer (AVRIS) and Thermal Infrared Multispectral Scanner (TIMS) data on September 29, 1989, and acquisition of Advanced Solid-State Array Spectroradiometer (ASAS), Polarimetric Synthetic Aperture Radar (AIRSAR), and Airborne Terrain Laser Altimeter System (ATLAS) data all within three months of each other. The sites covered were Lunar Crater Volcanic Field and Fish Lake Valley in Nevada; and Cima Volcanic Field, Death Valley, and Ubehebe Crater in California. Coincident field measurements included meteorological and atmospheric measurements, visible/near-infrared and thermal spectra, and characterization of geology and vegetation cover. The GRSFE airborne and field data will be reduced to a suite of standard products and submitted, along with appropriate documentation, to the Planetary Data System (PDS) and the Pilot Land Data System (PLDS). These data will be used for a variety of investigations including paleoclimatic studies in the arid southwestern United States, and analysis of Magellan data. GRSFE data will also be used to support Mars Observer Laser Altimeter (MOLA) and Mars Rover Sample Return (MRSR) simulation studies.
Author

N91-25462*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
HIGH-RESOLUTION MEASUREMENTS OF SURFACE TOPOGRAPHY WITH AIRBORNE LASER ALTIMETRY AND THE GLOBAL POSITIONING SYSTEM c43
James B. Garvin, Jack L. Bufton, John F. Cavanaugh, William B. Krabill, Thomas D. Clem, Earl B. Frederick, and John L. Ward (National Aeronautics and Space Administration. Wallops Flight Facility, Wallops Island, VA.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 145-146 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

Recently, an airborne lidar system that measures laser pulse time-of-flight and the distortion of the pulse waveform upon reflection from earth surface terrain features was developed and is now operational. This instrument is combined with Global Positioning System (GPS) receivers and a two-axis gyroscope for accurate recovery of aircraft position and pointing attitude. The laser altimeter system is mounted on a high-altitude aircraft platform and operated in a repetitively-pulsed mode for measurements of surface elevation profiles at nadir. The laser transmitter makes use of recently developed short-pulse diode-pumped solid-state laser technology in Q-switched Nd:YAG operating at its fundamental wavelength of 1064 nm. A reflector telescope and silicon avalanche photodiode are the basis of the optical receiver. A high-speed time-interval unit and a separate high-bandwidth waveform digitizer under microcomputer control are used to process the backscattered pulses for measurements of terrain. Other aspects of the lidar system are briefly discussed.
Author

N91-25463*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
THE MILLIMETER-WAVE IMAGING RADIOMETER (MIR) c43
A. J. Gasiewski, D. M. Jackson (Georgia Inst. of Tech., Atlanta.), R. F. Adler, L. R. Dod, and J. C. Shiue *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 147-148 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

The Millimeter-Wave Imaging Radiometer (MIR) is a new instrument being designed for studies of airborne passive microwave retrieval of tropospheric water vapor, clouds, and precipitation parameters. The MIR is a total-power cross-track scanning radiometer for use on either the NASA ER-2 (high-altitude) or DC-8 (medium altitude) aircraft. The current design includes millimeter-wave (MMW) channels at 90, 166, 183 +/- 1,3,7, and 220 GHz. An upgrade for the addition of submillimeter-wave (SMMW) channels at 325 +/- 1,3,7 and 340 GHz is planned. The nadiral spatial resolution is approximately 700 meters at mid-altitude when operated aboard the NASA ER-2. The MIR consists of a scanhead and data acquisition system, designed for installation in the ER-2 superpod nose cone. The scanhead will house the receivers (feedhorns, mixers, local oscillators, and preamplifiers), a scanning mirror, hot and cold calibration loads, and temperature sensors. Particular attention is being given to the characterization of the hot and cold calibration loads through

both laboratory bistatic scattering measurements and analytical modeling. Other aspects of the MIR and the data acquisition system are briefly discussed, and diagrams of the location of the MIR in the ER-2 superpod nosecone and of the data acquisition system are presented. Author

N91-25464*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AIRBORNE SULFUR TRACE SPECIES INTERCOMPARISON CAMPAIGN: SULFUR DIOXIDE, DIMETHYLSULFIDE, HYDROGEN SULFIDE, CARBON DISULFIDE, AND CARBONYL SULFIDE c45
Gerald L. Gregory, James M. Hoell, Jr., and Douglas D. Davis (Georgia Inst. of Tech., Atlanta.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 149-152 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 13B

Results from an airborne intercomparison of techniques to measure tropospheric levels of sulfur trace gases are presented. The intercomparison was part of the NASA Global Tropospheric Experiment (GTE) and was conducted during the summer of 1989. The intercomparisons were conducted on the Wallops Electra aircraft during flights from Wallops Island, Virginia, and Natal, Brazil. Sulfur measurements intercompared included sulfur dioxide (SO2), dimethylsulfide (DMS), hydrogen sulfide (H2S), carbon disulfide (CS2), and carbonyl sulfide (OCS). Measurement techniques ranged from filter collection systems with post-flight analyses to mass spectrometer and gas chromatograph systems employing various methods for measuring and identifying the sulfur gases during flight. Sampling schedules for the techniques ranged from integrated collections over periods as long as 50 minutes to one- to three-minute samples every ten or fifteen minutes. Several of the techniques provided measurements of more than one sulfur gas. Instruments employing different detection principles were involved in each of the sulfur intercomparisons. Also included in the intercomparison measurement scenario were a host of supporting measurements (i.e., ozone, nitrogen oxides, carbon monoxide, total sulfur, aerosols, etc.) for purposes of: (1) interpreting results (i.e., correlation of any noted instrument disagreement with the chemical composition of the measurement environment); and (2) providing supporting chemical data to meet CITE-3 science objectives of studying ozone/sulfur photochemistry, diurnal cycles, etc. The results of the intercomparison study are briefly discussed. Author

N91-25465*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
AN ELECTRICALLY SCANNED THINNED ARRAY RADIOMETER FOR EARTH REMOTE SENSING Abstract Only c43
Andrew J. Griffis, Calvin T. Swift (Massachusetts Univ., Amherst.), and David LeVine *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 153 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

Interferometric aperture synthesis is being investigated as an alternative to real aperture measurements of the brightness temperature of the earth from low earth orbit. Aperture synthesis allows for the realization of space borne microwave systems with attractive spatial resolution characteristics. Radio astronomers have performed aperture synthesis by cross-correlating spatially separated antenna element pairs for some time. The application of this technique to the observation of a distributed source, as opposed to a point source in radio astronomy, presents a novel and challenging application of aperture synthesis. The demonstration of this geophysical application of aperture synthesis was carried out by constructing and flight testing a phototype instrument, the Electrically Scanned Thinned Array Radiometer (ESTAR). The subsequent data analysis and image reconstruction yielded an image of the eastern shore of Virginia. In the past year, more data of the same region were taken and analyzed, as well as for other regions of Virginia, Pennsylvania, and Maine. Improvements were made in the image reconstruction technique and in the system electronics for the current and upcoming instruments (ESTAR00 and ESTAR0, respectively), particularly in terms of calibration instrumentation and techniques. Author

N91-25466*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
REMOTE SENSING OF EARTH'S ATMOSPHERE AND SURFACE USING A DIGITAL ARRAY SCANNED INTERFEROMETER: A NEW TYPE OF IMAGING SPECTROMETER c43
Philip D. Hammer, Francisco P. J. Valero, David L. Peterson, and William Hayden Smith (Washington Univ., Seattle.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 161-163 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

The capabilities of the digital array scanned interferometer (DASI) class of instruments for measuring terrestrial radiation fields over the visible to mid-infrared are evaluated. DASI's are capable of high throughput, sensitivity and spectral resolution and have the potential for field-of-view spatial discrimination (an imaging spectrometer). The simplicity of design and operation of DASI's make them particularly suitable for field and airborne platform based remote sensing. The long term objective is to produce a versatile field instrument which may be applied toward a variety of atmospheric and surface studies. The operation of DASI and its advantages over other spectrometers are discussed. Author

N91-25467*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AIRBORNE WATER VAPOR DIAL SYSTEM AND MEASUREMENTS OF WATER AND AEROSOL PROFILES c43
Noah S. Higdon and Edward V. Browell *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 167-168 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

The Lidar Applications Group at NASA Langley Research Center has developed a differential absorption lidar (DIAL) system for the remote measurement of atmospheric water vapor (H2O) and aerosols from an aircraft. The airborne H2O DIAL system is designed for extended flights to perform mesoscale investigations of H2O and aerosol distributions. This DIAL system utilizes a Nd:YAG-laser-pumped dye laser as the off-line transmitter and a narrowband, tunable Alexandrite laser as the on-line transmitter. The dye laser has an oscillator/amplifier configuration which incorporates a grating and prism in the oscillator cavity to narrow the output linewidth to approximately 15 pm. This linewidth can be maintained over the wavelength range of 725 to 730 nm, and it is sufficiently narrow to satisfy the off-line spectral requirements. In the Alexandrite laser, three intracavity tuning elements combine to produce an output linewidth of 1.1 pm. These spectral devices include a five-plate birefringent tuner, a 1-mm thick solid etalon and a 1-cm air-spaced etalon. A wavelength stability of +/- 0.35 pm is achieved by active feedback control of the two Fabry-Perot etalons using a frequency stabilized He-Ne laser as a wavelength reference. The three tuning elements can be synchronously scanned over a 150 pm range with microprocessor-based scanning electronics. Other aspects of the DIAL system are discussed. Author

N91-25468*# National Aeronautics and Space Administration. Wallops Flight Facility, Wallops Island, VA.
AIRBORNE OCEANOGRAPHIC LIDAR PARTICIPATION IN THE US JOINT GLOBAL OCEAN FLUX STUDY (JGOFS) Abstract Only c43
Frank E. Hoge and Robert N. Swift (EG and G Washington Analytical Services Center, Inc., Lanham, MD.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 175 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

The U.S. JGOFS is part of a major international field experiment which the National Science Foundation (NSF) is conducting during the decade. It will combine ship and aircraft data collected in both the Atlantic and Pacific oceans. The primary data collected

by the Airborne Oceanographic Lidar (AOL) is laser-induced chlorophyll fluorescence together with the concurrent laser-induced water Raman backscatter and phycoerythrin fluorescence. Passive solar-induced up-welling radiances and down-welling solar irradiance are also acquired. Results from the 1989 Atlantic mission as well as plans for use of the new long-range Wallops P-3 during the upcoming Equatorial Pacific mission are presented. Author

N91-25469*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
THE ADVANCED MICROWAVE PRECIPITATION RADIOMETER: A NEW AIRCRAFT RADIOMETER FOR PASSIVE PRECIPITATION REMOTE SENSING **c43**
Robbie E. Hood, Roy W. Spencer, and Mark W. James *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 179-180 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

Past studies of passive microwave measurements of precipitating systems have yielded broad empirical relationships between hydrometeors and microwave transmission. In general, these relationships fall into two categories of passive microwave precipitation retrievals rely upon the observed effect of liquid precipitation to increase the brightness temperature of a radiometrically cold background such as an ocean surface. A scattering-based method is based upon the effect that frozen hydrometeors tend to decrease the brightness temperature of a radiometrically warm background such as land. One step toward developing quantitative brightness temperature-rain rate relationships is the recent construction of a new aircraft instrument sponsored by National Aeronautics and Space Administration/Marshall Space Flight Center (NASA/MSFC). This instrument is the Advanced Microwave Precipitation Radiometer (AMPR) designed and built by Georgia Tech Research Institute to fly aboard high altitude research aircraft such as the NASA ER-2. The AMPR and its accompanying data acquisition system are mounted in the Q-bay compartment of the NASA ER-2. Author

N91-25470*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LIDAR MEASUREMENTS OF POLAR STRATOSPHERIC CLOUDS DURING THE 1989 AIRBORNE ARCTIC STRATOSPHERIC EXPEDITION **c46**
Syed Ismail and Edward V. Browell *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 181-182 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 04A

The Airborne Arctic Stratospheric Expedition (AASE) was conducted during January to February 1989 from the Sola Air Station, Norway. As part of this expedition, the NASA Langley Research Center's multiwavelength airborne lidar system was flown on the NASA Ames Research Center's DC-8 aircraft to measure ozone (O3) and aerosol profiles in the region of the polar vortex. The lidar system simultaneously transmitted laser beams at 1064, 603, 311, and 301.5 nm to measure atmospheric scattering, polarization and O3 profiles. Long range flights were made between Stavanger, Norway, and the North Pole, and between 40 deg W and 20 deg E meridians. Eleven flights were made, each flight lasting an average of 10 hours covering about 8000 km. Atmospheric scattering ratios, aerosol polarizations, and aerosol scattering ratio wavelength dependences were derived from the lidar measurements to altitudes above 27 km. The details of the aerosol scattering properties of lidar observations in the IR, VIS, and UV regions are presented along with correlations with the national meteorological Center's temperature profiles. Author

N91-25471*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
A PC-BASED MULTISPECTRAL SCANNER DATA EVALUATION WORKSTATION: APPLICATION TO DAEDALUS SCANNERS **c43**
Gary J. Jedlovec, Mark W. James, Matthew R. Smith, and Robert J. Atkinson (General Electric Co., Huntsville, AL.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 183-184 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

In late 1989, a personal computer (PC)-based data evaluation workstation was developed to support post flight processing of Multispectral Atmospheric Mapping Sensor (MAMS) data. The MAMS Quick View System (QVS) is an image analysis and display system designed to provide the capability to evaluate Daedalus scanner data immediately after an aircraft flight. Even in its original form, the QVS offered the portability of a personal computer with the advanced analysis and display features of a mainframe image analysis system. It was recognized, however, that the original QVS had its limitations, both in speed and processing of MAMS data. Recent efforts are presented that focus on overcoming earlier limitations and adapting the system to a new data tape structure. In doing so, the enhanced Quick View System (QVS2) will accommodate data from any of the four spectrometers used with the Daedalus scanner on the NASA ER2 platform. The QVS2 is designed around the AST 486/33 MHz CPU personal computer and comes with 10 EISA expansion slots, keyboard, and 4.0 mbytes of memory. Specialized PC-McIDAS software provides the main image analysis and display capability for the system. Image analysis and display of the digital scanner data is accomplished with PC-McIDAS software. Author

N91-25472*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
HYPERSPECTRAL DATA ANALYSIS FOR ESTIMATION OF FOLIAR BIOCHEMICAL CONTENT ALONG THE OREGON TRANSECT **c43**
Lee F. Johnson (TGS Technology, Inc., Moffett Field, CA.) and David L. Peterson *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 185-186 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

The NASA Oregon Transect Ecosystem Research (OTTER) project completed a data acquisition phase. Data were acquired with several airborne imaging spectrometers. Included were the Airborne Visible and Infrared Imaging Spectrometer (AVIRIS) aboard the ER-2, the Advanced Solidstate Array Spectrometer (ASAS) aboard the C-130, and the Fluorescence Line Imager (FLI) and Compact Airborne Spectrographic Imager (CASI), both aboard light aircraft. In addition, Spectron visible and near-infrared data were acquired in transects across study areas from a low-altitude ultralight craft. Sunphotometer data were taken approximately coincident with each overflight for atmospheric correction of the aircraft data. Author

N91-25473*# National Aeronautics and Space Administration. John C. Stennis Space Center, Bay Saint Louis, MS.
END-TO-END REMOTE SENSING AT THE SCIENCE AND TECHNOLOGY LABORATORY OF JOHN C. STENNIS SPACE CENTER **c43**
Patrick Kelly, Douglas Rickman, and Eric Smith *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 187-188 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

The Science and Technology Laboratory (STL) of Stennis Space Center (SSC) was developing an expertise in remote sensing for more than a decade. Capabilities at SSC/STL include all major areas of the field. STL includes the Sensor Development Laboratory (SDL), Image Processing Center, a Learjet 23 flight platform, and on-staff scientific investigators. Author

N91-25474*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
AMES RESEARCH CENTER C-130 **c43**
Mark A. Koozer *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 189-191 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

The C130 Earth Resources Aircraft provides a platform for a variety of sensors that collect data in support of terrestrial and

atmospheric projects sponsored by NASA in coordination with Federal, state, university, and industry investigators. This data is applied to research in the areas of forestry, agriculture, land use and land cover analysis, hydrology, geology, photogrammetry, oceanography, meteorology, and other earth science disciplines. The C130 is a platform aircraft flying up to 25,000 feet above sea level at speeds between 150 and 330 knots True Air Speed. The aircraft is capable of precise flight line navigation by means of an optical borescope from which line guidance is provided to the pilots. Author

N91-25475*# National Aeronautics and Space Administration. Wallops Flight Facility, Wallops Island, VA.
APPLYING KINEMATIC GPS TO AIRBORNE LASER REMOTE SENSING Abstract Only **c43**
William B. Krabill, Chreston F. Martin, and Robert N. Swift *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 195 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

Results from the application of differential carrier phase tracking of the GPS constellation of satellites to precise positioning of an aircraft are presented. These aircraft positions are utilized in the process of providing geodetic quality position information for airborne laser footprint location on the surface of the earth. The combination of these techniques provides a rapid, cost effective means for collecting geodetic and topographic data, including sea surface topography. Operational techniques and constraints, along with result from recently collected data, are presented. Author

N91-25476*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
STATUS REPORT ON THE LAND PROCESSES AIRCRAFT SCIENCE MANAGEMENT OPERATIONS WORKING GROUP Abstract Only **c43**
James G. Lawless and Lisa J. Mann (TGS Technology, Inc., Moffett Field, CA.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 201 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

Since its inception three years ago, the Land Processes Aircraft Science Management Operations Working Group (MOWG) provided recommendations on the optimal use of the Agency's aircraft in support of the Land Processes Science Program. Recommendations covered topics such as aircraft and sensor usage, development of long-range plans, Multisensor Airborne Campaigns (MAC), program balance, aircraft sensor databases, new technology and sensor development, and increased University scientist participation in the program. Impacts of these recommendations improved the efficiency of various procedures including the flight request process, tracking of flight hours, and aircraft usage. The group also created a bibliography focused on publications produced by Land Processes scientists from the use of the aircraft program, surveyed NASA funded PI's on their participation in the aircraft program, and developed a planning template for multi-sensor airborne campaigns. Benefits from these activities are summarized. Author

N91-25477*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
THE USE OF AIRCRAFT-BASED THERMAL INFRARED MULTISPECTRAL SCANNER (TIMS) DATA TO MEASURE SURFACE ENERGY BUDGETS ON A LANDSCAPE SCALE Abstract Only **c43**
Jeffrey C. Luvall *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 205 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

A series of Thermal Infrared Multispectral Scanner Data (TIMS) was collected over the H. J. Andrews experimental forest in western Oregon and at the Coweeta Hydrologic Laboratory in North Carolina. Flight lines were overlapped with an 8 to 28 minute time difference between flight lines. Concurrent radiosonde measurements of atmospheric profiles of air and dew point temperatures provided inputs to LOWTRAN6 for atmospheric radiance corrections of the TIMS data. Surface temperature differences over time between flight lines allowed the development of thermal response numbers (TRN) which characterized the thermal response of the different surface types. The polygons containing mostly soil and bare rock had the lowest TRN whereas the forested polygons were the highest. Results indicate that forest canopy temperatures measured by the TIMS are comparable to needle thermocouples temperatures. ET models developed from the TIMS data obtained similar ET rates as those using energy balance techniques. Author

N91-25478*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
THE SURFACE WAVE DYNAMICS EXPERIMENT (SWADE) Abstract Only **c48**
Erik Mollo-Christensen and J. David Oberholtzer (National Aeronautics and Space Administration. Wallops Flight Facility, Wallops Island, VA.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 219-222 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 08C

The Surface Wave Dynamics Experiment is designed to provide the basic data needed to understand the wind-wave interactions in the open ocean. During the period of October 1990 through March 1991 two discus, four meteorological buoys, and several other specialized buoys will collect continuous in-situ data. During three intensive periods of study, several aircraft and an airship will collect synoptic data from the study area in the Atlantic east of the Wallops Flight Facility. Data from the buoys will be collected by aircraft and ARGOS data links. Instrumentation descriptions as well as preliminary data from the first intensive study period are presented. Author

N91-25479*# National Aeronautics and Space Administration. John C. Stennis Space Center, Bay Saint Louis, MS.
AIRBORNE GROUND PENETRATING RADAR (GPR) FOR PEAT ANALYSES IN THE CANADIAN NORTHERN WETLANDS STUDY **c43**
Ramona E. Pelletier-Travis *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 225-226 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

The study was conducted as part of the NASA Biospherics Research on Emissions from Wetlands (BREW) program. An important aspect of the program is to investigate the terrestrial production and atmospheric distribution of methane and other gases contributing to global warming. Multi-kilometer transects of airborne (helicopter) Ground Penetrating Radar (GPR) data were collected periodically along the 100 km distance from the coast inland so as to obtain a regional trend in peat depth and related parameters. Global Positioning System (GPS) data were simultaneously collected from the helicopter to properly georeference the GPR data. Additional 50 m ground-based transects of GPR data were also collected as a source of ground truthing, as a calibration aid for the airborne data sets, and as a source of higher resolution data for characterizing the strata within the peat. In situ peat depth probing and soil characterizations from excavated soil pits were used to verify GPR findings. Results from the ground-based data are presented. Author

N91-25480*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
AIRBORNE COHERENT CONTINUOUS WAVE CO2 DOPPLER LIDARS FOR AEROSOL BACKSCATTER MEASUREMENT **c43**
Jeffry Rothermel, William D. Jones, Diana Hampton, Vandana Srivastava (Universities Space Research Association, Huntsville, AL.), and Maurice Jarzembski *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 235-236 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

Two focused coherent, continuous wave (CW) lidars have been

developed by the Marshall Space Flight Center (MSFC) for airborne and ground-based measurement of aerosol backscatter coefficients. The first of these instruments uses a mixture of CO2 and other gases, and measures backscatter at 10.6 m. The second lidar uses an isotope of carbon dioxide, which enables lasing at 9.1 m. The 10.6 m backscatter measurement serves as a reference to allow variations in backscatter due to aerosol concentration to be distinguished from variations due to spectral variability. The 10.6 m lidar has been used in airborne field programs since 1981. Development of the 9.1 m lidar was completed in early 1989. Recently, both lidars were flown on the NASA/Ames Research Center DC-8 research aircraft in the remote Pacific Basin as part of the NASA GLObal Backscatter Experiment (GLOBE) survey missions. The GLOBE program, of which the survey missions are the centerpieces, supports design and simulation studies for NASA's prospective Laser Atmospheric Wind Sounder (LAWS). Author

N91-25481*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SCIENCE REQUIREMENTS AND FEASIBILITY/DESIGN STUDIES OF A VERY-HIGH-ALTITUDE AIRCRAFT FOR ATMOSPHERIC RESEARCH c05
Philip B. Russell, David P. Lux, R. Dale Reed (PRC Systems Services Co., Hampton, VA.), Max Loewenstein, and Steven Wegener *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 241-242 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 01C

The advantages and shortcomings of currently available aircraft for use in very high altitude missions to study such problems as polar ozone or stratosphere-troposphere exchange pose the question of whether to develop advanced aircraft for atmospheric research. To answer this question, NASA conducted a workshop to determine science needs and feasibility/design studies to assess whether and how those needs could be met. It was determined that there was a need for an aircraft that could cruise at an altitude of 30 km with a range of 6,000 miles with vertical profiling down to 10 km and back at remote points and carry a payload of 3,000 lbs. Author

N91-25482*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
C-130 AUTOMATED DIGITAL DATA SYSTEM (CADDS) c43
C. P. Scofield and Chien Nguyen *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 243-244 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

Real time airborne data acquisition, archiving and distribution on the NASA/Ames Research Center (ARC) C-130 has been improved over the past three years due to the implementation of the C-130 Automated Digital Data System (CADDS). CADDS is a real time, multitasking, multiprocessing ROM-based system. CADDS acquires data from both avionics and environmental sensors inflight for all C-130 data lines. The system also displays the data on video monitors throughout the aircraft. Author

N91-25483*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THE HIGH ALTITUDE AIRCRAFT PROGRAM OF NASA/AMES RESEARCH CENTER Abstract Only c43
Gary Shelton and Bruce Coffland *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 245 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

The ER-2 aircraft are used in NASA's Airborne Science and Applications Program as readily deployable high altitude sensor platforms to collect remote sensing and in situ data on Earth resources, celestial phenomena, atmospheric dynamics, and oceanic processes. Additionally, these aircraft are used for electronic sensor research and development and satellite investigative support. The scientific endeavors supported by these aircraft are listed. Author

N91-25484*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
THE REMOTELY PILOTED VEHICLE AS AN EARTH SCIENCE RESEARCH AIRCRAFT c43
Dean S. Smith and Jack L. Bufton (University Research Foundation, Greenbelt, MD.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 249-250 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

A brief study was conducted at the Goddard Space Flight Center to identify existing remotely piloted vehicle (RPV) capabilities and to determine if the use of an RPV was advantageous and practical for Earth science investigations. A total of 17 instrument systems were identified. It was found that RPV's were considered especially valuable for dangerous missions, e.g., flights through volcano plumes and hurricanes, long duration profiles over inaccessible regions such as the Antarctic, and very low altitude ocean profiling missions. Author

N91-25485*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
REMOTE SENSING OF THE SEASONAL VARIATION OF CONIFEROUS FOREST STRUCTURE AND FUNCTION c43
Michael Spanner and Richard Waring (Oregon State Univ., Corvallis.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 257-259 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

One of the objectives of the Oregon Transect Ecosystem Research (OTTER) project is the remotely sensed determination of the seasonal variation of leaf area index (LAI) and absorbed photosynthetically active radiation (APAR). These measurements are required for input into a forest ecosystem model which predicts net primary production evapotranspiration, and photosynthesis of coniferous forests. Details of the study are given. Author

N91-25486*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
VISIBLE AND NEAR INFRARED OBSERVATION ON THE GLOBAL AEROSOL BACKSCATTER EXPERIMENT (GLOBE) c43
James D. Spinhirne, John F. Cavanaugh, S. Chudamani (State Univ. of New York, Stony Brook.), Jack L. Bufton, and Robert J. Sullivan *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 261-262 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

The Global Aerosol Backscatter Experiment (GLOBE) was intended to provide data on prevailing values of atmospheric backscatter cross-section. The primary intent was predicting the performance of spaceborne lidar systems, most notably the Laser Atmospheric Wind Sounder (LAWS) for the Earth Observing System (EOS). The second and related goal was to understand the source and characteristics of atmospheric aerosol particles. From the GLOBE flights, extensive data was obtained on the structure of clouds and the marine planetary boundary layer. A notable result for all observations is the consistency of the large increases in the aerosol scattering ratio for the marine boundary layer. Other results are noted. Author

N91-25487*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
PROFILES OF ALPHA 13 C AND ALPHA D IN METHANE FROM THE LOWER STRATOSPHERE c46
Martin Wahlen, Nori Tanaka, Robert Henry (New York State Dept. of Environmental Conservation, Albany.), and Harley Weyer *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 285-286 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 13B

Methane is an important greenhouse gas of biogenic and anthropogenic origin for which global budgets are being constructed from a variety of data. One approach to the global methane budget is the use of the stable isotopes C-13 and D, and the radionuclide

C-14 as tracers. The authors measured the isotopic composition of methane from various sources and in tropospheric air for a number of locations. Here, the authors report on the isotopic composition of methane from the lower stratosphere. Measurements of this concentration in the stratosphere can yield estimates for the kinetic isotope effects in the methane destruction reactions. These effects have to be known for quantitative isotopic methane budgets. Author

N91-25488*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
ADVANCED SOLID-STATE ARRAY SPECTROMETER (ASAS) DATA SETS FROM THE 1990 FIELD SEASON: A UNIQUE LOOK AT TWO FORESTED ECOSYSTEMS c43
Charles L. Walthall, James Irons, Phillip Dabney, David L. Peterson, Darrel L. Williams, Lee F. Johnson (TGS Technology, Inc., Moffett Field, CA.), and K. Jon Ranson *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 287-288 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

The Advanced Solid-state Array Spectrometer (ASAS) is a pointable imaging spectrometer which uses a solid-state array to acquire imagery of terrestrial targets in 29 spectral bands from .4 to .8 microns. Performance and calibration of the instrument are described. The ASAS data sets obtained in 1990 provide a unique look at forest canopies from two different forest regions of the North America continent under varying temporal, spectral, and bidirectional conditions. These data sets will be used to study such parameters as the albedo of forest canopies, the dynamics of scene radiation due to factors such as canopy architecture, moisture stress, leaf chemistry, topography, and understory composition. Author

N91-25489*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
HIGH ALTITUDE AIRCRAFT DIRECTION USING REAL-TIME SCIENTIFIC ANALYSIS OF TELEMETERED DATA Abstract Only c47
Steven Wegener, K. Roland Chan, Leonhard Pfister, and John Arvesen *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 293-294 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 04B

Microscale and some mesoscale scientific targets are often too small and fast moving in a dynamic atmosphere. In this environment the ER-2 may spend only a small time sampling the phenomena of interest. The ER-2 scientists currently rely on post-flight analysis to determine the success of the mission and to provide input for planning the next flight. Real time analysis, combined with realistic modeling, can provide important clues to significantly enhance the probability of success in the investigation of specific scientific targets. Author

N91-25490*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
THE 1990 FOREST ECOSYSTEM DYNAMICS MULTISENSOR AIRCRAFT CAMPAIGN c43
Darrel L. Williams and K. Jon Ranson *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 295-296 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

The overall objective of the Forest Ecosystem Dynamics (FED) research activity is to develop a better understanding of the dynamics of forest ecosystem evolution over a variety of temporal and spatial scales. Primary emphasis is being placed on assessing the ecosystem dynamics associated with the transition zone between northern hardwood forests in eastern North America and the predominantly coniferous forests of the more northerly boreal biome. The approach is to combine ground-based, airborne, and satellite observations with an integrated forest pattern and process model which is being developed to link together existing models of forest growth and development, soil processes, and radiative transfer. Author

N91-25491*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
A POINTABLE, HELICOPTER-BASED REMOTE SENSING DATA ACQUISITION SYSTEM FOR COLLECTING BIDIRECTIONAL REFLECTANCE DATA c43
Darrel L. Williams, Charles L. Walthall, and Douglas Young (National Aeronautics and Space Administration. Wallops Flight Facility, Wallops Island, VA.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 297-298 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

Discussed here is a new configuration of a helicopter-borne remote sensing system to support field measurements programs such as studies of forest decline damage associated with atmospheric deposition and the Forest Ecosystems Dynamics project. In this new configuration, the sensor payload is mounted externally on a hinged pallet located on the starboard side of the Bell Iroquois UH-1B (HUEY) helicopter. The sensor payload includes a set of bore-sighted instruments consisting of a Barnes Modular Multiband Radiometer (MMR), a Spectron Engineering (SE) 590 spectroradiometer, an Everest infrared temperature sensor, and a Sony CCD video camera with a 10x zoom lens. The system was tested and excellent data was acquired in 1990. Author

N91-25492*# National Aeronautics and Space Administration. John C. Stennis Space Center, Bay Saint Louis, MS.
POLARIMETRIC RADAR FOR ASSESSING SUBSURFACE CHARACTERISTICS Abstract Only c43
Shih-Tseng Wu *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 303 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

The potential of using the NASA airborne polarimetric radar system to assess the subsurface characteristics of the Rogers lake bed and the Atchadafaya Basin study sites is described. Preliminary analysis of acquired data indicated that VV polarization is capable of muddy water penetration and that the radar system could be used to assess underwater sediment distribution. Statistical analysis of the data will provide insight on the depth of muddy water penetration. Author

N91-25493*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
AIRCRAFT REMOTE SENSING OF PHYTOPLANKTON SPATIAL PATTERNS DURING THE 1989 JOINT GLOBAL OCEAN FLUX STUDY (JGOFS) NORTH ATLANTIC BLOOM EXPERIMENT c43
James A. Yoder (Rhode Island Univ., Kingston.) and Frank E. Hoge *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 305 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

Mesoscale phytoplankton chlorophyll variability near the Joint Global Ocean Flux study sites along the 20 W meridian at 34 N, 47 N, and 59 N is discussed. The NASA P-3 aircraft and the Airborne Oceanographic Lidar (AOL) system provides remote sensing support for the North Atlantic Bloom Experiment. The principal instrument of the AOL system is the blue-green laser that stimulates fluorescence from photoplankton chlorophyll, the principal photosynthetic pigment. Other instruments on the NASA P-3 aircraft include up- and down-looking spectrometers, PRT-5 for infrared measurements to determine sea surface temperature, and a system to deploy and record AXBTs to measure subsurface temperature structure. Author

N91-25494# Joint Publications Research Service, Arlington, VA.
JPRS REPORT: SCIENCE AND TECHNOLOGY. USSR: EARTH SCIENCES
9 Jan. 1991 24 p Transl. into ENGLISH from various Russian articles
(JPRS-UES-91-001) Avail: NTIS HC/MF A03

Abstracts of research on geology, meteorology, oceanography, atmospheric physics, and ecology are given. Author

43 EARTH RESOURCES AND REMOTE SENSING

Includes remote sensing of earth resources by aircraft and spacecraft; photogrammetry; and aerial photography.

For instrumentation see *35 Instrumentation and Photography.*

N91-25495# Geological Survey, Reston, VA.
WORLD NONBAUXITE ALUMINUM RESOURCES EXCLUDING ALUNITE
J. W. Hosterman, S. H. Patterson, and E. E. Good 1990 85 p
(PB91-137745; USGS-PP-1076-C; LC-89-600402) Avail: NTIS HC/MF A05 CSCL 08G

Information on potential nonbauxite aluminum resources excluding alunite is given. The nonbauxite resources having the best potential for extraction of aluminum are alunite, high-alumina clay, and aluminous igneous rocks; those having less potential are dawsonite-bearing rocks, aluminous phosphate rocks, saprolite, aluminous metamorphic rocks, aluminous shale, coal waste, and coal ash. With the exception of alunite, all these resources are discussed. The high-alumina clays are composed of minerals of the kaolin group--kaolinite, halloysite, dickite, and nacrite. Kaolinite is by far the most abundant, and it is the major component in a variety of high-alumina clays. High-alumina clays have a maximum alumina content of about 39 weight percent. However, no large deposits are pure, and most high-alumina clay deposits are 25 to 35 weight percent alumina. GRA

N91-25496# Technische Univ., Delft (Netherlands). Faculty of Geodetic Engineering.
AUTOMATIC EXTRACTION OF ROADS FROM SPOT IMAGES Thesis
M. E. deGunst Nov. 1990 121 p
(ETN-91-99417) Avail: NTIS HC/MF A06

The development of a system for semi automatic extraction of roads from SPOT images is described. Digital image processing techniques supply automatic methods to process the huge amount of data acquired by satellites. Characteristics of the SPOT satellite, like a finer ground resolution, make research into the extraction of roads in satellite images more attractive. The idea is to create initially an interactive mode. Human experience obtained by controlling the algorithm is formulated in rules to automize more parts of the system. An overalll conclusion for previous work is that a combination of techniques is required for road extraction. Various techniques are organized in two levels. The two level contains three methods for segmentation: classification with multispectral and structural information, dynamic programming in a region of interest and profile analysis. The high level controls the segmentation level. This road interpretation level has four tasks: test the quality of results from the segmentation level; closer analysis of the local situation; recognition of road features; control over the segmentation level including start, stop, adaptation of parameters, sequence and integration of segmentation methods. The rules in the high level initiate a knowledge based approach. Techniques could be added to both levels. The type of landscapes in the SPOT data set, the urban agglomeration of western Holland, complicates the extraction of roads. The narrow grey level range of SPOT and the presence of texture, noise and striping influence the results. An effective preprocessing is desirable. ESA

N91-25497# Technische Univ., Delft (Netherlands). Sectie Fysische, Meetkundige en Ruimte Geodesie.
ON THE COMPUTATION OF THE GEOID AND ITS ERRORS WITH SPECIAL ATTENTION TO THE INNER ZONE Thesis
Erik deMin Aug. 1990 97 p
(ETN-91-99421) Avail: NTIS HC/MF A05

The several geoid computation methods are studied. Global geopotential models that describe the long wavelength contribution to the geoid, the conventional Stokes' integral and collocation are treated and related. The error in the geoid is discussed. Apart from the so called propagation errors and discretization errors, systematic errors in the gravity data and model errors are treated. Numerical effects of the computation are discussed. An outline is given of how to plan a gravity survey, dependent on a desired geoid precision. It should be noted here that a simple standard procedure seems not to be possible and that a lot of aspects should be further studied before all ins and outs are fully understood. ESA

N91-25498# Technische Univ., Delft (Netherlands). Sectie Fysische, Meetkundige en Ruimte Geodesie.
FOURIER TECHNIQUES IN PHYSICAL GEODESY: A FUNDAMENTAL APPROACH Thesis
Karel Zuidweg Oct. 1990 85 p
(ETN-91-99422) Avail: NTIS HC/MF A05

The use of Fourier techniques in physical geodesy is discussed and a derivation of the Fourier solution from the basics of potential theory without too much concession to rigor is presented. The signal analysis and Fourier theory are reviewed with stress on the duality in Fourier transforms. Effects occurring when a signal is not represented in its original form are schematized so that the associated aliasing and leakage can be reviewed structurally. A boundary value problem is solved step by step to show how the result can be reduced to a real world situation. A range of functionals can then be connected to the Fourier solution, resulting in a pocket guide to planar physical geodesy. ESA

N91-25499# Technische Univ., Delft (Netherlands). Faculty of Geodesy.
STRICT LEAST SQUARES ADJUSTMENT OF THE GEOMETRIC CONDITIONS IN A DIGITAL COORDINATE SET Thesis
T. A. Konvalinka Feb. 1990 145 p
(ETN-91-99423) Avail: NTIS HC/MF A07

The application of geometric information in a map during the strict least squares solution of a digitized coordinate set to the Rijks-Driehoeks (RD) system is addressed. A method to deal with currently practiced geometric correction which consists of a visual manual correction by an operator is described. The use of geometric information in a map in the strict least squares adjustment is investigated because the method of correction has disadvantages where the least squares solution does not. The digitized coordinate set consisting of single points is connected to the RD system using the model with observation equations and then geometric condition adjustment is performed on the connected coordinates. The connection of two point fields using a nonlinear model is addressed. Geometric information is concluded to be applicable in a much better way than practised currently and, although it is not yet possible to do the least squares adjustment on the conditions of the whole map in practice, it is possible to find a strict solution locally. ESA

N91-25500# Winand Staring Centre, Wageningen (Netherlands).
ASSESSMENT OF THE GREEN AREAS OF RIYADH (SAUDIA ARABIA)
T. N. M. Visser 1990 38 p
(Rept-21; ISSN-0924-3062; ETN-91-99439) Copyright Avail: NTIS HC/MF A03

As a component of the Rising Groundwater Management Study (RGMS) performed by the Arriyadh Development Authority (ADA), a study is perfomed regarding the use of irrigation water in and around the city of Riyadh. Vegetated areas are mapped using SPOT and LANDSAT Thematic Mapper satellite imagery. Water requirements and actually applied volumes are determined. on subhara (administrative unit) basis. Both raster and vector vegetation maps were produced to serve as a basis for further analysis on the Urban Intelligence System (UIS) of ADA. ESA

N91-25501# Nevada Univ., Las Vegas. Water Resources Center.
GEOPHYSICAL MODELING OF THE STATIC WATER LEVEL

R. Bochicchio Apr. 1991 39 p
(Contract DE-AC08-90NV-10845)
(DE91-011796; DOE/NV-10845/5) Avail: NTIS HC/MF A03

The objective of this study is to determine if a geophysical investigation technique could be used to delineate depth to static water level to within 20 meters in several areas of the Nevada Test Site (NTS). Using noninvasive geophysical methods to obtain water-level data is potentially faster and more cost-effective than drilling wells, especially in the areas concerned, where water-level depths vary from approximately 200 to 600 meters. Electrical geophysical methods are well-suited for water-level delineation. The depth to the static water level is often related to that of the saturated zone, and the saturated zone often has a different electrical resistivity character than the adjacent unsaturated material. Most of the time, this will be a resistivity decrease, due to the presence of water instead of air in the pore spaces. However, a saturated zone with a resistive matrix may show a resistivity increase compared to an unsaturated layer composed of more conductive material, such as clay. The analytical method is to use known depths and electrical resistivities of the static water level to obtain simulated geophysical field data. These simulated data are referred to as the synthetic sounding curve. The synthetic sounding curve will be analyzed to see if it can be used to predict the static water level. DOE

N91-25448*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
NASA/AMES RESEARCH CENTER'S SCIENCE AND APPLICATIONS AIRCRAFT PROGRAM Abstract Only
G. Warren Hall *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 79 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25449*# National Aeronautics and Space Administration. Wallops Flight Facility, Wallops Island, VA.
GOODARD SPACE FLIGHT CENTER/WALLOPS FLIGHT FACILITY AIRBORNE GEOSCIENCE SUPPORT CAPABILITY
Roger L. Navarro *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 81-83 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25450*# Sterling Software, Moffett Field, CA.
THE PILOT LAND DATA SYSTEM (PLDS) AT THE AMES RESEARCH CENTER MANAGES AIRCRAFT DATA IN COLLABORATION WITH AN ECOSYSTEM RESEARCH PROJECT
Gary Angelici, Lidia Popovici, and Jay Skiles *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 93-95 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25451*# National Aeronautics and Space Administration. John C. Stennis Space Center, Bay Saint Louis, MS.
AIRCRAFT LASER DERIVED CHLOROPHYLL DISTRIBUTION ACROSS THE ICELAND-FAEROE FRONT Abstract Only
Robert A. Arnone and Paul E. LaViolette *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 97 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25460*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
NASA DC-8 AIRBORNE RESEARCH LABORATORY
Leo H. DeGreef *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 133-136 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25461*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
THE GEOLOGIC REMOTE SENSING FIELD EXPERIMENT (GRSFE): THE FIRST GEOLOGY MULTISENSOR AIRBORNE CAMPAIGN Abstract Only
Diane L. Evans and Raymond E. Arvidson (Washington Univ., Seattle.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 137 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25462*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
HIGH-RESOLUTION MEASUREMENTS OF SURFACE TOPOGRAPHY WITH AIRBORNE LASER ALTIMETRY AND THE GLOBAL POSITIONING SYSTEM
James B. Garvin, Jack L. Bufton, John F. Cavanaugh, William B. Krabill, Thomas D. Clem, Earl B. Frederick, and John L. Ward (National Aeronautics and Space Administration. Wallops Flight Facility, Wallops Island, VA.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 145-146 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25463*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
THE MILLIMETER-WAVE IMAGING RADIOMETER (MIR)
A. J. Gasiewski, D. M. Jackson (Georgia Inst. of Tech., Atlanta.), R. F. Adler, L. R. Dod, and J. C. Shiue *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 147-148 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25465*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
AN ELECTRICALLY SCANNED THINNED ARRAY RADIOMETER FOR EARTH REMOTE SENSING Abstract Only
Andrew J. Griffis, Calvin T. Swift (Massachusetts Univ., Amherst.), and David LeVine *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 153 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25466*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
REMOTE SENSING OF EARTH'S ATMOSPHERE AND SURFACE USING A DIGITAL ARRAY SCANNED INTERFEROMETER: A NEW TYPE OF IMAGING SPECTROMETER
Philip D. Hammer, Francisco P. J. Valero, David L. Peterson, and William Hayden Smith (Washington Univ., Seattle.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 161-163 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25467*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AIRBORNE WATER VAPOR DIAL SYSTEM AND MEASUREMENTS OF WATER AND AEROSOL PROFILES
Noah S. Higdon and Edward V. Browell *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 167-168 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25468*# National Aeronautics and Space Administration. Wallops Flight Facility, Wallops Island, VA.
AIRBORNE OCEANOGRAPHIC LIDAR PARTICIPATION IN THE US JOINT GLOBAL OCEAN FLUX STUDY (JGOFS) Abstract Only
Frank E. Hoge and Robert N. Swift (EG and G Washington Analytical Services Center, Inc., Lanham, MD.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 175 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25469*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
THE ADVANCED MICROWAVE PRECIPITATION RADIOMETER: A NEW AIRCRAFT RADIOMETER FOR PASSIVE PRECIPITATION REMOTE SENSING
Robbie E. Hood, Roy W. Spencer, and Mark W. James *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 179-180 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25471*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
A PC-BASED MULTISPECTRAL SCANNER DATA EVALUATION WORKSTATION: APPLICATION TO DAEDALUS SCANNERS
Gary J. Jedlovec, Mark W. James, Matthew R. Smith, and Robert J. Atkinson (General Electric Co., Huntsville, AL.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 183-184 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25472*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
HYPERSPECTRAL DATA ANALYSIS FOR ESTIMATION OF FOLIAR BIOCHEMICAL CONTENT ALONG THE OREGON TRANSECT
Lee F. Johnson (TGS Technology, Inc., Moffett Field, CA.) and David L. Peterson *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 185-186 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25473*# National Aeronautics and Space Administration. John C. Stennis Space Center, Bay Saint Louis, MS.
END-TO-END REMOTE SENSING AT THE SCIENCE AND TECHNOLOGY LABORATORY OF JOHN C. STENNIS SPACE CENTER
Patrick Kelly, Douglas Rickman, and Eric Smith *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 187-188 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25474*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
AMES RESEARCH CENTER C-130
Mark A. Koozer *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 189-191 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25475*# National Aeronautics and Space Administration. Wallops Flight Facility, Wallops Island, VA.
APPLYING KINEMATIC GPS TO AIRBORNE LASER REMOTE SENSING Abstract Only
William B. Krabill, Chreston F. Martin, and Robert N. Swift *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 195 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25476*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
STATUS REPORT ON THE LAND PROCESSES AIRCRAFT SCIENCE MANAGEMENT OPERATIONS WORKING GROUP Abstract Only
James G. Lawless and Lisa J. Mann (TGS Technology, Inc., Moffett Field, CA.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 201 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25477*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
THE USE OF AIRCRAFT-BASED THERMAL INFRARED MULTISPECTRAL SCANNER (TIMS) DATA TO MEASURE SURFACE ENERGY BUDGETS ON A LANDSCAPE SCALE Abstract Only
Jeffrey C. Luvall *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 205 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25479*# National Aeronautics and Space Administration. John C. Stennis Space Center, Bay Saint Louis, MS.
AIRBORNE GROUND PENETRATING RADAR (GPR) FOR PEAT ANALYSES IN THE CANADIAN NORTHERN WETLANDS STUDY
Ramona E. Pelletier-Travis *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 225-226 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25480*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
AIRBORNE COHERENT CONTINUOUS WAVE CO2 DOPPLER LIDARS FOR AEROSOL BACKSCATTER MEASUREMENT
Jeffry Rothermel, William D. Jones, Diana Hampton, Vandana Srivastava (Universities Space Research Association, Huntsville, AL.), and Maurice Jarzembski *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 235-236 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25482*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
C-130 AUTOMATED DIGITAL DATA SYSTEM (CADDS)
C. P. Scofield and Chien Nguyen *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 243-244 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25483*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THE HIGH ALTITUDE AIRCRAFT PROGRAM OF NASA/AMES RESEARCH CENTER Abstract Only
Gary Shelton and Bruce Coffland *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 245 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25484*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
THE REMOTELY PILOTED VEHICLE AS AN EARTH SCIENCE RESEARCH AIRCRAFT
Dean S. Smith and Jack L. Bufton (University Research Foundation, Greenbelt, MD.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 249-250 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25485*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
REMOTE SENSING OF THE SEASONAL VARIATION OF CONIFEROUS FOREST STRUCTURE AND FUNCTION
Michael Spanner and Richard Waring (Oregon State Univ., Corvallis.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 257-259 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25486*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
VISIBLE AND NEAR INFRARED OBSERVATION ON THE GLOBAL AEROSOL BACKSCATTER EXPERIMENT (GLOBE)
James D. Spinhirne, John F. Cavanaugh, S. Chudamani (State

Univ. of New York, Stony Brook.), Jack L. Bufton, and Robert J. Sullivan *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 261-262 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25488*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
ADVANCED SOLID-STATE ARRAY SPECTROMETER (ASAS) DATA SETS FROM THE 1990 FIELD SEASON: A UNIQUE LOOK AT TWO FORESTED ECOSYSTEMS
Charles L. Walthall, James Irons, Phillip Dabney, David L. Peterson, Darrel L. Williams, Lee F. Johnson (TGS Technology, Inc., Moffett Field, CA.), and K. Jon Ranson *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 287-288 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25490*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
THE 1990 FOREST ECOSYSTEM DYNAMICS MULTISENSOR AIRCRAFT CAMPAIGN
Darrel L. Williams and K. Jon Ranson *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 295-296 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25491*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
A POINTABLE, HELICOPTER-BASED REMOTE SENSING DATA ACQUISITION SYSTEM FOR COLLECTING BIDIRECTIONAL REFLECTANCE DATA
Darrel L. Williams, Charles L. Walthall, and Douglas Young (National Aeronautics and Space Administration. Wallops Flight Facility, Wallops Island, VA.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 297-298 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25492*# National Aeronautics and Space Administration. John C. Stennis Space Center, Bay Saint Louis, MS.
POLARIMETRIC RADAR FOR ASSESSING SUBSURFACE CHARACTERISTICS Abstract Only
Shih-Tseng Wu *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 303 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25493*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
AIRCRAFT REMOTE SENSING OF PHYTOPLANKTON SPATIAL PATTERNS DURING THE 1989 JOINT GLOBAL OCEAN FLUX STUDY (JGOFS) NORTH ATLANTIC BLOOM EXPERIMENT
James A. Yoder (Rhode Island Univ., Kingston.) and Frank E. Hoge *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 305 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 05B

N91-25916*# Keene State Coll., NH. Dept. of Geography.
MASS BALANCE INVESTIGATION OF ALPINE GLACIERS THROUGH LANDSAT TM DATA Abstract Only
Klaus J. Bayr *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 12 Submitted for publication (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 08B

N91-25922*# Salisbury State Univ., MD. Dept. of Mathematical Sciences.
LAND ALTIMETRY USING SATELLITE DATA FROM THE GEOSAT SEA ALTIMETER Abstract Only
Philip E. Luft *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 19 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 08B

N91-25935*# Johns Hopkins Univ., Shadyside, MD.
THE USE OF AIRCRAFT AND SATELLITE REMOTE SENSING OF PHYTOPLANKTON CHLOROPHYLL CONCENTRATIONS IN CASE 2 ESTUARINE WATERS OF THE CHESAPEAKE BAY Abstract Only
Lawrence W. Harding, Jr. *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 33 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 08C

N91-25939*# Dillard Univ., New Orleans, LA. Urban Studies and Public Policy Inst.
INTEGRATING NASA'S LAND ANALYSIS SYSTEM (LAS) IMAGE PROCESSING SOFTWARE WITH AN APPROPRIATE GEOGRAPHIC INFORMATION SYSTEM (GIS): A REVIEW OF CANDIDATES IN THE PUBLIC DOMAIN Abstract Only
Gilbert L. Rochon *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 37 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 08B

44 ENERGY PRODUCTION AND CONVERSION

Includes specific energy conversion systems, e.g., fuel cells; global sources of energy; geophysical conversion; and windpower.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *28 Propellants and Fuels.*

N91-25502*# Texas A&M Univ., College Station. Dept. of Chemical Engineering.
A MATHEMATICAL MODEL OF THE MAXIMUM POWER DENSITY ATTAINABLE IN AN ALKALINE HYDROGEN/OXYGEN FUEL CELL Final Report
Michael C. Kimble and Ralph E. White Jun. 1991 125 p
(Grant NAG3-1043)
(NASA-CR-188613; NAS 1.26:188613) Avail: NTIS HC/MF A06 CSCL 10A

A mathematical model of a hydrogen/oxygen alkaline fuel cell is presented that can be used to predict the polarization behavior under various power loads. The major limitations to achieving high power densities are indicated and methods to increase the maximum attainable power density are suggested. The alkaline fuel cell model describes the phenomena occurring in the solid, liquid, and gaseous phases of the anode, separator, and cathode regions based on porous electrode theory applied to three phases. Fundamental equations of chemical engineering that describe conservation of mass and charge, species transport, and kinetic phenomena are used to develop the model by treating all phases as a homogeneous continuum. Author

N91-25503# Edgerton, Germeshausen and Grier, Inc., Idaho Falls, ID.
CONCEPTUAL GEOLOGIC MODEL AND NATIVE STATE MODEL OF THE ROOSEVELT HOT SPRINGS HYDROTHERMAL SYSTEM
D. D. Faulder 1991 12 p Presented at the 16th Annual Workshop on Geothermal Reservoir Engineering, Stanford, 22-24 Jan. 1991
(Contract DE-AC07-76ID-01570)
(DE91-010056; EGG-M-91027; CONF-910125-1) Avail: NTIS HC/MF A03

A conceptual geologic model of the Roosevelt Hot Springs hydrothermal system was developed by a review of the available

literature. The hydrothermal system consists of a meteoric recharge area in the Mineral Mountains, fluid circulation paths to depth, a heat source, and an outflow plume. A conceptual model based on the available data can be simulated in the native state using parameters that fall within observed ranges. The model temperatures, recharge rates, and fluid travel times are sensitive to the permeability in the Mineral Mountains. The simulation results suggest the presence of a magma chamber at depth as the likely heat source. A two-dimensional study of the hydrothermal system can be used to establish boundary conditions for further study of the geothermal reservoir. DOE

N91-25504# Oak Ridge National Lab., TN.
THERMAL ENERGY STORAGE Progress Report, Apr. 1989 - Mar. 1990
J. J. Tomlinson Mar. 1991 47 p
(Contract DE-AC05-84OR-21400)
(DE91-010455; ORNL/TM-11819) Avail: NTIS HC/MF A03

The Department of Energy (DOE) is supporting development of thermal energy storage (TES) as a means of efficiently coupling energy supplies to variable heating or cooling demands. Uses of TES include electrical demand-side management in buildings and industry, extending the utilization of renewable energy resources such as solar, and recovery of waste heat from periodic industrial processes. Technical progress in development of TES for specific diurnal and industrial applications under Oak Ridge National Laboratory's TES program from April 1989 to March 1990 is reported. DOE

N91-25505# Oak Ridge National Lab., TN.
MEXICAN-US COOPERATION ON RENEWABLE ENERGY PROGRAMS
D. B. Waddle 10 Apr. 1991 13 p
(Contract DE-AC05-84OR-21400)
(DE91-011083; ORNL/FTR-3883) Avail: NTIS HC/MF A03

I traveled to Mexico on April 1 with Pete Smith and Chris Rovero of Oak Ridge Associated Universities on a mission sponsored by the Agency for International Development (AID) to initiate a technical support project with Mexican government and private institutions. We met with officials of AID; the Programa Nacional de Solidaridad; the Laboratorio de Energia Solar; Instituto Investigaciones de Electricidad; Comision Federal de Electricidad; Compania de Luz y Fuerza del Centro; and several private firms to discuss the terms of support. An AIDE Memoire was drafted outlining the scope of future assistance. I traveled to San Jose, Cost Rica on April 7, 1991. There I met with Carlos Rodriguez, manager of Cooperativa Electrica de San Carlos, and Federico Baltodano, the director of BEL Ingenieria to discuss the San Lorenzo hydroelectric project. Details of an engineering and financial analysis outlining the costs and benefits of adding daily pondage to the project were discussed, as was the project development schedule and other issues. I returned to Oak Ridge on April 9, 1991. DOE

N91-25506# Technical Research Centre of Finland, Espoo.
USE OF PINCH-TECHNOLOGY IN THE DESIGN AND CALCULATION OF HEAT EXCHANGER NETWORKS
T. Kolehmainen, A. Kovero, H. Malinen, and S. Viinikainen Nov. 1990 94 p In FINNISH; ENGLISH summary
(DE91-771948; VTT-TIED-1182) Avail: NTIS HC/MF A05

Pinch-technology is a method for analyzing and designing the use of heat energy. It can be best applied to process industry which uses large amounts of heat energy. Pinch-technology is based on mass and heat balance of the concerned process. All the process streams are analyzed. The so-called hot composite curve consists of all the streams, which require cooling and the cold composite curve consists of all the streams, which require heating. With help of these curves, all the heat transfer of the process can be analyzed simultaneously. Optimal targets for energy consumption can be obtained before the design of the heat-exchanger network. These targets are based on economical optimization. Pinch-technology can be used also when designing heat and power cogeneration and for optimal placing of heat pumps. Computer programs and graphs are used when designing processes with the pinch-technology. The composite curves and energy consumption targets can be easily composed when using software based on pinch-technology. The topology of the heat-exchanger network in the early phases of design is convenient to present with graphical grid presentation. DOE

N91-25507# Midwest Research Inst., Golden, CO.
HIGH EFFICIENCY COPPER TERNARY THIN FILM SOLAR CELLS
B. M. Basol and V. K. Kapur (International Solar Electric Technology, Inglewood, CA.) Apr. 1991 24 p
(Contract DE-AC02-83CH-10093)
(DE91-002134; SERI/TP-214-4203) Avail: NTIS HC/MF A03

This report describes work to develop a high efficiency, thin film CuInSe2 solar cell using a potentially low-cost process. The technique used in this development program is a two-stage process. The two-stage process involves depositing the metallic elements of the CuInSe2 compound (i.e., Cu and In) on a substrate in the form of stacked layers, and then selenizing this stacked metallic film in an atmosphere containing Se. Early results showed that the electrodeposition/selenization technique could yield CuInSe2 films with good electrical and optical properties on small-area substrates. This report concentrates on the later half of the research effort; this portion was directed toward developing a two-stage process using evaporated Cu-In layers. The selenization technique has the potential of yielding solar cells with efficiencies in excess of 15 percent. DOE

N91-25508# Midwest Research Inst., Golden, CO.
SERI PHOTOVOLTAIC SUBCONTRACT REPORTS: ABSTRACTS AND DOCUMENT CONTROL INFORMATION, 1 AUGUST - 31 DECEMBER 1990
Apr. 1991 17 p
(Contract DE-AC02-83CH-10093)
(DE91-002150; SERI/TP-214-4207) Avail: NTIS HC/MF A03

This report contains the document control information and abstracts for Solar Energy Research Institute (SERI) Photovoltaic (PV) Program publications resulting from SERI's subcontracted PV research. The information is presented for reports published or distributed from August 1 through December 31, 1990. In the past, copies of the subcontractor reports were distributed to a broad spectrum of researchers in the field of photovoltaics at a considerable cost to the program. In an attempt to reduce costs and ensure that all researchers receive those current publications that are of specific interest to them, this report will outline these publications, organized by technology, on a regular basis. A list of additional publications and sources is included to provide the photovoltaic community with other sources of information. All of the documents represented here are available from the National Technical Information Service (NTIS) and can be purchased using the NTIS order form at the end of this document. Further information on a given subcontracted program may be obtained from the SERI technical monitor identified on each Document Control Page. This report includes information on the fabrication, testing, and properties of semiconductor materials used in solar cells. DOE

N91-25509# Sandia National Labs., Albuquerque, NM.
THE CONCEPT-90 PHOTOVOLTAIC CONCENTRATOR MODULE
A. B. Maish, T. D. Hund, M. A. Quintana, and C. J. Chiang (General Electric Co., Princeton, NJ.) 1991 4 p Presented at the 10th European Photovoltaic Solar Energy Conference and Exhibition, Lisbon, Portugal, 8-12 Apr. 1991
(Contract DE-AC04-76DP-00789)
(DE91-010852; SAND-90-2167C; CONF-910425-2) Avail: NTIS HC/MF A01

The Concept-90 module introduces a new generation of photovoltaic concentrator module technology that emphasizes manufacturability, safety, reliability, and low cost. Innovative features include a new flat cell assembly design, a smaller scale to improve the efficiency of the new point contact cells, and integral use of plastics to completely enclose the cell string and to form

the module housing, sidewalls and backplane. The design and outdoor test results of the first prototype module are described.
DOE

N91-25510*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
STIRLING MACHINE OPERATING EXPERIENCE
Brad Ross (Stirling Technology Co., Richland, WA.) and James E. Dudenhoefer 1991 8 p Presented at the 26th Intersociety Energy Conversion Engineering Conference, Boston, MA, 4-9 Aug. 1991; sponsored by the American Nuclear Society, SAE, the American Chemical Society, AIAA, ASME, IEE, and the American Inst. of Chemical Engineers
(NASA-TM-104487; E-6334; NAS 1.15:104487) Avail: NTIS HC/MF A02 CSCL 10B

Numerous Stirling machines have been built and operated, but the operating experience of these machines is not well known. It is important to examine this operating experience in detail, because it largely substantiates the claim that Stirling machines are capable of reliable and lengthy lives. The amount of data that exists is impressive, considering that many of the machines that have been built are developmental machines intended to show proof of concept, and were not expected to operate for any lengthy period of time. Some Stirling machines (typically free-piston machines) achieve long life through non-contact bearings, while other Stirling machines (typically kinematic) have achieved long operating lives through regular seal and bearing replacements. In addition to engine and system testing, life testing of critical components is also considered.
Author

N91-25511# Stirling Thermal Motors, Inc., Ann Arbor, MI.
HEAT PIPE GAS COMBUSTION SYSTEM ENDURANCE TEST FOR STIRLING ENGINE Final Report, May 1990 - Sep. 1990
P. Mahrle Dec. 1990 38 p
(Contract GRI-5086-293-1416)
(PB91-161257; GRI-90/0297) Avail: NTIS HC/MF A03 CSCL 10B

Stirling Thermal Motors, Inc. has been developing a general purpose Heat Pipe Gas Combustion (HPGC) system suitable for use with the STM4-120 Stirling engine. The HPGC consists of a parallel plate recuperative preheater, a finned heat pipe evaporator, and a film-cooled gas combustor. The principal component is the heat pipe evaporator which collects and distributes the liquid sodium over the heat transfer surfaces. The liquid sodium evaporates and flows to the condensers where it delivers its latent heat. Given here are the test results of the endurance tests run on a Gas Fired Stirling Engine (GFSE).
Author

N91-25236*# Science Applications International Corp., San Diego, CA.
THE FEASIBILITY OF SOLAR REFLECTOR PRODUCTION FROM LUNAR MATERIALS FOR SOLAR POWER IN SPACE
In Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 15 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 10A

45 ENVIRONMENT POLLUTION

Includes atmospheric, noise, thermal, and water pollution.

N91-25512# PRC Environmental Management, Inc., Chicago, IL.
ULTROX INTERNATIONAL ULTRAVIOLET RADIATION/OXIDATION TECHNOLOGY: APPLICATIONS ANALYSIS REPORT
G. Welshans, K. Topudurti, B. Sootkoos, and S. Weinberg Sep. 1990 79 p
(Contract EPA-68-03-3484)
(PB91-129759; EPA/540/A5-89/012) Avail: NTIS HC/MF A05 CSCL 13B

In support of the U.S. Environmental Protection Agency's (EPA) Superfund Innovative Technology Evaluation (SITE) Program, both treatment efficiency and economic cost from the SITE demonstration and seven case studies are evaluated. The Ultrox technology simultaneously uses ultraviolet (UV) radiation, ozone, and hydrogen peroxide to oxidize dissolved organic contaminants found in groundwater or wastewater. Under the SITE Program, the Ultrox technology demonstration was conducted at the Lorentz Barrel and Drum (LB and D) site, San Jose, California, in February and March of 1989. During the demonstration, the Ultrox system achieved volatile organic compound (VOC) removals greater then 90 percent. The majority of VOC's were removed through chemical oxidation. However, stripping also contributed toward removal of a few VOC's such as 1,1,1-trichloroethane (1,1,1-TCA) and 1,1-dichloroethan (1,1-DCA). The treated groundwater met the applicable National Pollutant Discharge Elimination System (NPDES) standards for discharge into a local waterway. In addition, there were no harmful air emissions to the atmosphere from the Ultrox system, which is equipped with an offgas treatment unit.
GRA

N91-25513# Radian Corp., Research Triangle Park, NC.
URBAN AIR TOXICS MONITORING PROGRAM, 1989
R. A. McAllister, W. H. Moore, J. Rice, E. Bowles, and D. P. Dayton Oct. 1990 278 p
(Contract EPA-68-D-80014)
(PB91-148262; EPA/450/4-91/001) Avail: NTIS HC/MF A13 CSCL 13B

From January 1989 through January 1990 samples of ambient air were collected at 14 sites in the eastern part of the U.S. Every 12 days, air was integrated over 24-hour periods into passivated stainless steel canisters. Simultaneously, air was drawn through cartridges containing dinitrophenyl hydrazine to collect carbonyl compounds. The samples were analyzed at a central laboratory for a total of 37 halogenated and aromatic hydrocarbons, formaldehyde, acetaldehyde, and other oxygenated species. The hydrocarbon species were analyzed by gas chromatography/multiple detectors and gas chromatography/mass spectrometry, while the carbonyl species were analyzed by liquid chromatography. An extensive quality assurance program was carried on to secure high quality data. Complete data for all the carbonyl samples are presented.
GRA

N91-25514# Radian Corp., Research Triangle Park, NC.
URBAN AIR TOXIC MONITORING PROGRAM ALDEHYDE RESULTS, 1989 Final Report
R. A. McAllister, D. L. Epperson, and R. F. Jongleux Jan. 1991 149 p
(Contract EPA-68-D-80014)
(PB91-148288; DCN-90-262-045-09; EPA/450/4-91/006) Avail: NTIS HC/MF A07 CSCL 13B

The U.S. Environmental Protection Agency (EPA) developed the Urban Air Toxic Monitoring Program (UATMP) to help state and local agencies assess the nature and magnitude of their air toxic problems. The UATMP sampler collects ambient air samples at urban sites in 6-liter (L) SUMMA-treated stainless steel canisters. At the same time, through a separate heated sample line, ambient air samples are drawn in parallel through duplicate cartridges which trap the carbonyl compounds from the ambient air. The aldehyde cartridges collected at the UATMP sites for 1989 were extracted and analyzed by the Atmospheric Research and Exposure Assessment Laboratory (AREAL) of the U.S. EPA at Research Triangle Park, NC for formaldehyde, acetaldehyde, and acetone. These carbonyls were selected as target compounds for the 1989 UATMP. The report presents the data summaries and other data assessments for the carbonyl samples collected during the 1989 UATMP season. The air toxics compounds collected in canisters for the 1989 UATMP season are reported separately.
GRA

N91-25515 State Univ. of New York, Albany.
THE STUDY OF OZONE BEHAVIOR OVER BRAZIL Ph.D. Thesis

Maria Albertina Pier Costa 1990 402 p
Avail: Univ. Microfilms Order No. DA9109312

Ozone behavior over the earth has been studied by many researchers. To understand ozone patterns over Brazil, time-series analyses were applied as statistical tools, utilizing data obtained from the Nimbus Seven satellite total ozone mapping spectrometer (TOMS) over three inland and four ocean grid cells. Maps of ozone concentrations over Brazil were produced for the years 1979, 1983, and 1987. Results indicated: a steady decrease of ozone concentration over the study area from 1979 to 1987; a decline in ozone concentrations were dependent on the level of the previous months; strong correlations between ozone concentrations and sunspot activity for inland areas but not for ocean area; and troposphere ozone concentrations mimic the total ozone column with a strong seasonality signal. Author

N91-25516 California Univ., Davis.
LASER SCATTERING OF SPHERICAL PARTICLES WHERE PARTICLE DIAMETER IS APPROXIMATELY EQUAL TO THE WAVELENGTH AS A TEST OF MIE THEORY USING A POLAR NEPHELOMETER: DESIGN, CONSTRUCTION, CALIBRATION, LABORATORY AND FIELD ANALYSES Ph.D. Thesis
Phillip John Graves 1990 226 p
Avail: Univ. Microfilms Order No. DA9110635

In order to better understand the effects of microparticles on the light scattering characteristics of aerosols, researchers designed, constructed, calibrated, and performed experiments with the Davis Polar Nephelometer. Due to the unique rotating mirror system, this machine is far more versatile than previous nephelometers. Researchers used the machine to size industrial latex microspheres, and found that the spheres retained water on the surface, making them larger than expected. The researchers also pioneered efforts to use the nephelometer for the determination of the index of refraction of an aerosol. Additionally, scattering cross sections and efficiencies were determined with the machine. Lastly, the machine was taken in the field to test the scattering characteristics of ambient aerosols. Preliminary results from all the tests performed were encouraging.
Dissert. Abstr.

N91-25517# Maryland Univ., Baltimore. Dept. of Environmental Health and Safety.
APPLICATION OF BEST AVAILABLE SCIENCE TO THE REGULATORY PROCESS
A. A. Moghissi 1991 14 p
(Contract DE-FG02-90EW-00003)
(DE91-010363; DOE/EW-00003/2) Avail: NTIS HC/MF A03

The current grant is a continuation of a previous grant awarded to the Institute for Regulatory Science. In July, 1989, the functions of the Institute were transferred to the University of Maryland and the studies started at the Institute were continued at the University. The current grant started February 1, 1990. Therefore, much of the discussion in this progress report relies upon the grant funded at the Institute for Regulatory Science. This progress report covers the period from February 1, 1990 to January 31, 1991. The objective of the project is to assure that societal decisions are based on the best available science (BAS). A great deal of progress was made to establish relevant organizations for the development of consensus on relevant scientific information. During the next year, emphasis will be placed on Resource Conservation and Recovery Act (RCRA), particularly as related to its reauthorization and mixed waste. DOE

N91-25518# Pacific Northwest Lab., Richland, WA.
FIELD CALIBRATION OF SOIL-CORE MICROCOSMS FOR EVALUATING FATE AND EFFECTS OF GENETICALLY ENGINEERED MICROORGANISMS IN TERRESTRIAL ECOSYSTEMS
H. Bolton, Jr., J. K. Fredrickson, S. A. Bentjen, D. J. Workman, S. W. Li, and J. M. Thomas Apr. 1991 84 p
(Contract DE-AC06-76RL-01830)
(DE91-011258; PNL-7667) Avail: NTIS HC/MF A05

Pacific Northwest Laboratory compared intact soil-core microcosms and the field for ecosystem structural and functional properties after the introduction of a model genetically engineered microorganism (GEM). This project used two distinct microbial types as model GEMs, Gram-negative Pseudomonas sp. RC1, which was an aggressive root colonizer, and Gram-positive Streptomyces lividans TK24. The model GEMs were added to surface soil in separate studies, with RC1 studied throughout the growth of winter wheat (Triticum aestivum), while TK24 was studied throughout a ten month period. Also, RC1 was used in studies conducted during two consecutive field seasons (1988 to 1990) to determine how year-to-year field variability influenced the calibration of microcosms with the field. The main conclusions of this research were that intact soil-core microcosms can be useful to simulate the field for studies of microbial fate and effects on ecosystem structural and functional properties. In general, microcosms in the growth chamber, which simulated average field variations, were similar to the field for most parameters or differences could be attributed to the great extremes in temperature that occurred in the field compared to the microcosms. Better controls of environmental variables including temperature and moisture will be necessary to more closely simulate the field for future use of microcosms for risk assessment. DOE

N91-25519# National Center for Atmospheric Research, Boulder, CO.
ENHANCED RESEARCH PROGRAM ON THE LONG-RANGE CLIMATIC EFFECTS OF INCREASED ATMOSPHERIC CARBON DIOXIDE: A CONTINUATION
W. M. Washington and G. A. Meehl Jan. 1989 12 p
(Contract DE-AI01-79EV-10220)
(DE91-010617; DOE/EV-10220/T2) Avail: NTIS HC/MF A03

Carbon dioxide research during 1988 at the National Center for Atmospheric Research (NCAR) was concentrated in four areas: (1) the publication of three experiments (1 x CO2, 2 x CO2, and transients) with fully coupled atmospheric and oceanic general circulation models (GCM's); (2) the involvement of the DOE sponsored intercomparison of GMC's; (3) the analysis of the coupled control run to study El Nino and La Niua; and (4) the continuing development of multitasked versions of atmospheric and oceanic GCM's. DOE

N91-25520# Argonne National Lab., IL.
TRADEABLE PERMITS FOR GLOBAL WARMING CONTROL: IMPLICATIONS FOR REGIONAL ECONOMIES AND PUBLIC UTILITIES
R. F. Kosobud, K. G. Quinn (Illinois Univ., Chicago.), and T. A. Daly Feb. 1991 6 p Presented at the 53rd Annual Meeting and Exhibit of the American Power Conference, Chicago, 20 Apr. - May 1991
(Contract W-31-109-eng-38)
(DE91-010822; ANL/CP-72696; CONF-9104106-2) Avail: NTIS HC/MF A02

A cumulative emission permit system (CEPS) is examined, within both a theoretical and empirical framework. A key feature of this system is that the total volume of emissions leading to the ultimate acceptable gas concentrations is embodied in permits placed on the market immediately. The analysis of resulting initial and intertemporal permit prices yields strong reasons for ranking this policy above carbon or other taxes, direct regulation, or other measures. Economic theory provides a way to project how regional decision makers, including public utilities, would adjust abatement costs to prices. These implications are tested with a mathematical programming model that provides estimates of global and regional time paths of permit prices, energy use, and trace gas emissions.
DOE

N91-25521# Colorado Univ., Boulder. Inst. of Arctic and Alpine Research.
REDUCE UNCERTAINTY IN PROJECTION OF FUTURE SEA-LEVEL CHANGE DUE TO ICE WASTAGE
M. F. Meier 1991 5 p
(Contract DE-FG02-87ER-60570)
(DE91-010933; DOE/ER-60570/3) Avail: NTIS HC/MF A01

Three basic goals were stated in the original proposal. These were: (1) develop an understanding of the heat and mass flow into subfreezing snow and firn, in order to model the evolution of the temperature distribution and the infiltration rates through the firn; (2) relate changes in climate, as given by general circulation model predictions, to changes in the surface mass and energy balances of glaciers; and (3) use the above results to analyze the effects of changed surface mass and energy balances on the flow of meltwater through snow and firn, and on the runoff from these glaciers, in a CO2-affected climate. This final report summarizes the progress toward these goals. The primary product of this research program has been the communication of this progress in the form of publications in the scientific literature and presentations at scientific meetings. Research activities in the past three years have provided a new basis for modeling of multiphase flow in subfreezing snow, new field data on the structural properties of Arctic firn pertinent to hydrological modeling, and estimates of sea level change in response to changing patterns of runoff from the Greenland Ice Sheet. Forecasts of future sea level changes from all glacier runoff sources may be in error by amounts on the order of +8 cm over the next 150 years, due to the lag in generating runoff to the sea. Specific research products include two distributed-parameter models of water flow through snow with melting and freezing, a theoretical model of wetting-front advance into subfreezing snow for inclusion in a future model, and a simple large-scale model of the response of Greenland runoff in a changing climate which provides estimates of the effect of melt water refreezing phenomena on sea level changes in response to a range of possible future climates. DOE

N91-25522# Delaware Univ., Lewes. Coll. of Marine Studies.
CHEMISTRY OF ATMOSPHERIC PRECIPITATION AT LEWES, DELAWARE AS PART OF THE MAP3S NETWORK
J. R. Scudlark and T. M. Church Apr. 1991 14 p
(Contract DE-FG02-85ER-60293)
(DE91-011148; DOE/ER-60293/5) Avail: NTIS HC/MF A03

Precipitation was collected and analyzed by event at Lewes, DE from 3/78 through 12/90 as part of the Multistate Atmospheric Power Production Pollution Study (MAP3S) Network. Overall, the major ion concentrations are somewhat less than inland MAP3S sites, probably indicative of the influence of relatively clean marine air masses at the coast. The long term average pH is 4.35, with observed summer maxima and winter minima fore the acid components. No long term trends in precipitation composition were observed. The contribution of marine sulfate is relatively small (13 pct.), albeit significant, and can be precisely corrected from background continental sources. The major source of acid components at this site are associated with storm trajectories from the midwest and southeast U.S. The atmospheric deposition of inorganic nitrogen may provide an ecologically significant source of this primary nutrient to sustain coastal marine productivity. DOE

N91-25523# Argonne National Lab., IL.
ENERGY TECHNOLOGY AND EMISSIONS CONTROL FOR ACID RAIN ABATEMENT IN ASIA
D. G. Streets 1990 29 p Presented at the 2nd Workshop on Acid Rain in Asis, Bangkok, Thailand, 19-22 Nov. 1990
(Contract W-31-109-eng-38)
(DE91-011162; ANL/CP-72403; CONF-9011144-2) Avail: NTIS HC/MF A03

After more than ten years of research, acid rain is a sufficiently serious problem in North America to warrant control action. The acid rain problem has become a threat to the Asian continent as well. Emissions of sulfur dioxide and nitrogen oxides are already high and announced plans for increases in coal use by countries in the region imply a major increase in emissions in the future. This will inevitably lead to greater incidence of acid rain and probably significant environmental damage in some locations. The purpose is to examine some of the issues relating to acid rain control technology in Asia and to suggest ways to include technology options in integrated simulation models of acid rain in Asia. DOE

N91-25524# California Univ., Berkeley. Dept. of Physics.
INTERNATIONAL CONFERENCE ON PHYSIOLOGICAL PROCESS STUDIES IN THE ARCTIC
F. S. Chapin, II 1991 31 p Conference held in Toronto, Ontario, 1-3 Aug. 1989
(Contract DE-FG03-89ER-60901)
(DE91-011199; CONF-8908276-Summ) Avail: NTIS HC/MF A03

The conference on physiological process studies in the Arctic was held to summarize the current understanding of plant physiological processes in the Arctic. Participants reviewed the current understanding of arctic ecophysiology and discussed the role of physiology in controlling ecosystem processes such as productivity and nutrient cycling. Emphasis was placed on ways in which ecophysiological studies might provide insight into possible responses of arctic ecosystems to global climatic change. The major conclusions of the workshop were that, although a great deal is known about the adaptations of arctic plants to their physical environment, the biotic interactions among plants and between plants and other organisms are more important in governing the distribution of plants in the Arctic. Future research in arctic physiological ecology should emphasize biotic interactions, feedbacks and time lags that modify plant response to environment, and the roles that plants play as regulators of ecosystem processes. DOE

N91-25525# Pacific Northwest Lab., Richland, WA.
METHODS FOR ESTIMATING THE UNCERTAINTY OF CLIMATE CHANGE EFFECTS IN A CROP MODEL
A. M. Liebetrau and M. J. Scott Nov. 1990 16 p Presented at the IEEE Conference on Neural Information Processing: Natural and Synthetic, Denver, 26-29 Nov. 1990
(Contract DE-AC06-76RL-01830)
(DE91-011238; PNL-SA-18786; CONF-901150-2) Avail: NTIS HC/MF A03

One of the most difficult problems facing policy makers in deciding what to do about the possible effects of future climate change on the earth's natural and human resources (the so-called Greenhouse Effect) is how to proceed in the face of serious uncertainty. Nowhere has this been made more obvious than in the uncertainty associated with the effects of climate on agriculture. The U.S. Department of Energy has funded a program to develop or modify the analytical tools required to estimate the effects of changed climate on a number of natural resource sectors. In the agricultural sector, the primary analytical tool used in this activity has been the Erosion Production Impact Calculator (EPIC). EPIC is a mathematical cropping systems model developed originally to examine the relationship between soil erosion and soil productivity, but which has now been modified to account for the effects of climate and CO2 fertilization. The EPIC computer code is a highly detailed tool that incorporates extensive information on weather, plant physiology, and farming practices. A process is described of uncertainty analysis that will evaluate simultaneously the effects of temporal and geographic variability of weather, uncertainty of farm prices, and availability of different farming practices to estimate the effect of climate change on farm income. The method and data that are used in making this evaluation is discussed; information is provided on the sampling schemes used in the exercise; and the empirical application is also discussed of the techniques, together with conclusions. DOE

N91-25526# Pacific Northwest Lab., Richland, WA.
POTENTIAL IMPACTS OF GLOBAL CLIMATE CHANGE ON SOLAR THERMAL POWER SYSTEMS
T. A. Williams, D. R. Brown, J. A. Dirks, K. K. Humphreys, and J. L. LaMarche Apr. 1990 7 p Presented at the 12th Annual American Society of Mechanical Engineers (ASME) International Solar Energy Conference, Miami, 1-4 Apr. 1990
(Contract DE-AC06-76RL-01830)
(DE91-011239; PNL-SA-17245; CONF-900449-11) Avail: NTIS HC/MF A02

As evidence mounts that carbon dioxide (CO2) concentrations in the atmosphere are increasing, debate is growing over what

should be done to mitigate the anthropogenic sources of CO2. The purpose of this paper is to take an initial look at whether the global climate change problem could impact the economic feasibility of solar thermal electric plants relative to fossil-fueled power plants. Specifically, this paper compares the costs for reducing CO2 emissions from the utility industry through two strategies: substituting a solar thermal central receiver power plant for coal-fired plants versus removing/disposing of the carbon from the emissions of coal plants. For the technologies analyzed and the set of assumptions used, using solar thermal technology to generate electricity appears to be a less expensive way of reducing CO2 emissions than removing the CO2 emissions from the coal-fired plant. While additional studies would be needed to comprehensively evaluate other alternatives, the results shown here indicate that solar thermal power systems should be carefully considered among the alternatives for reducing CO2 emissions. DOE

N91-25527# Japan Atomic Energy Research Inst., Tokyo.
INTERCOMPARISON OF MEASURING AND EVALUATION METHODS FOR ENVIRONMENTAL RADIATIONS
Kimiaki Saito, Toshi Nagaoka, Ryuichi Sakamoto, Masahiro Tsutsumi, Shigeru Moriuchi (Japan Atomic Energy Research Inst., Tokai.), and Masaharu Okano Nov. 1990 49 p In JAPANESE; ENGLISH summary
(DE91-772227; JAERI-M-90-188) Avail: NTIS HC/MF A03

This report presents the results of the cooperative research by IPCR and JAERI. In order to investigate the accuracy and characteristics of the measurement and evaluation methods for environmental radiations, developed independently by IPCR and by JAERI, field experiments were performed using the both methods under the same conditions at the same time. The experiments were performed at fixed points on the ground, in a moving car and in a flying helicopter. Discussion was made on the basis of the comparison of the results from the both methods. The exposure rates from the IPCR method agreed within 10 percent with those from the JAERI method, however the former were systematically higher than the latter. Since the evaluated exposure rate components due to (238)U-series, (232)Th-series and (40)K showed apparent differences between the IPCR method and the JAERI method, further investigation is necessary for the positions and widths of the applied energy bands and the coefficients in the equations to evaluate the components. In measurements in a moving vehicle, the sequential data should be gathered per sufficiently short distance to distinguish the local change of the radiation level when it changes greatly according to the location. The aerial data showed that the exposure rates from terrestrial gamma rays in the region west of the Abe river are apparently higher than those in the Kanto district. DOE

N91-25528# Radian Corp., Research Triangle Park, NC.
GLOBAL WARMING MITIGATION POTENTIAL OF THREE TREE PLANTATION SCENARIOS Final Report, Sep. 1989 - Jun. 1990
R. L. Peer, D. L. Campbell, and W. G. Hohenstein Feb. 1991 68 p Sponsored in part by the Energy Engineering Research Lab.
(Contract EPA-68-02-4286)
(PB91-159608; EPA/600/7-91/003) Avail: NTIS HC/MF A04 CSCL 13B

Results are given of an analysis of three alternative uses of forests in the U.S. to reduce atmospheric carbon dioxide concentrations. The alternatives are planting trees with no harvesting, traditional forestry, and short rotation intensive culture of trees for biomass. Since forests provide a sink for carbon by fixing carbon dioxide to produce biomass, halting deforestation and creating new forests have been proposed as ways to slow the buildup of carbon in the Earth's atmosphere. Author

N91-25529# Forest Service, Ogden, UT. Intermountain Research Station.
STATISTICAL PROCEDURES FOR DISAGGREGATION APPLICABLE TO MODELING CLIMATIC EFFECTS ON FOREST GROWTH
A. R. Stage Feb. 1991 9 p Presented at the Forest/Climate Interactions: Scale Transition from Individual Leaves to the Global Workshop, Boulder, CO, 25-27 Sep. 1990
(PB91-160820; FSRN/INT-395) Avail: NTIS HC/MF A02 CSCL 13B

Many processes that are observable for an entire population can be difficult to observe for the individuals in the population. In a conceptually similar problem, a production process may be influenced by factors that vary in a temporal sequence during production, but the yield is observable only at the completion of the process. In this note, statistical procedures for disaggregation, originally developed by Fisher, are reintroduced with suggestions for how they might be applied to problems of modeling effects of climate and stand structure on forest growth. GRA

N91-25455*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TROPOSPHERIC OZONE AND AEROSOLS MEASURED BY AIRBORNE LIDAR DURING THE 1988 ARCTIC BOUNDARY LAYER EXPERIMENT
Edward V. Browell, Carolyn F. Butler, and Susan A. Kooi (ST Systems Corp., Hampton, VA.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 119-120 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 13B

N91-25456*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AIRBORNE LIDAR MEASUREMENTS OF OZONE DURING THE 1989 AIRBORNE ARCTIC STRATOSPHERIC EXPEDITION
Edward V. Browell, Marta A. Fenn, and Susan A. Kooi (ST Systems Corp., Hampton, VA.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 121-122 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 13B

N91-25459*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
THE Cl-36 IN THE STRATOSPHERE
Bruce Deck, Martin Wahlen, Harley Weyer, Peter Kubik, Pankaj Sharma, and Harry Gove (Rochester Univ., NY.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 131-132 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 13B

N91-25464*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AIRBORNE SULFUR TRACE SPECIES INTERCOMPARISON CAMPAIGN: SULFUR DIOXIDE, DIMETHYLSULFIDE, HYDROGEN SULFIDE, CARBON DISULFIDE, AND CARBONYL SULFIDE
Gerald L. Gregory, James M. Hoell, Jr., and Douglas D. Davis (Georgia Inst. of Tech., Atlanta.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 149-152 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 13B

N91-25921*# Puerto Rico Univ., San Juan. Terrestrial Ecology Div.
ECOLOGICAL APPLICATIONS OF HIGH RESOLUTION SPECTROMETRY Abstract Only
William T. Lawrence *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 18 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 13B

N91-25926*# Buena Vista Coll., Storm Lake, IA. School of Natural Sciences.
THE ROLE OF POLAR STRATOSPHERIC CLOUDS ON TOTAL OZONE MINIHOLE EVENTS Abstract Only
Joseph L. Sabutis *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 24 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 13B

46 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; ionospheric and magnetospheric physics; and geomagnetism.

For space radiation see *93 Space Radiation.*

N91-25530# Geological Survey, Reston, VA.
SYSTEMATIC PALEONTOLOGY OF QUATERNARY OSTRACODE ASSEMBLAGES FROM THE GULF OF ALASKA. PART 1: FAMILIES CYTHERELLIDAE, BAIRDIDAE, CYTHERIDAE, LEPTOCYTHERIDAE, LIMNOCYTHERIDAE, EUCYTHERIDAE, KRITHIDAE, CUSHMANIDEIDAE
E. M. Brouwers 1990 79 p
(PB91-138602; PP-1510; LC-89-600370) Avail: NTIS HC/MF A05 CSCL 08G

Thirty-two species of podocopid ostracodes are reported from Quaternary sediments of the Gulf of Alaska continental shelf. Fifteen new species are described, twelve previously described species are illustrated, and five species are placed in open nomenclature. GRA

N91-25531# Geological Survey, Anchorage, AK. Water Resources Div.
GEOHYDROLOGY AND GROUND-WATER GEOCHEMISTRY AT A SUB-ARCTIC LANDFILL, FAIRBANKS, ALASKA
J. S. Downey and P. O. Sinton 1990 34 p Prepared in cooperation with Fairbanks-North Star Borough, AK
(PB91-140590; USGS/WRI-90-4022) Avail: NTIS HC/MF A03 CSCL 08G

The Fairbanks-North Star Borough landfill is located on silt, sand, and gravel deposits of the Tanana River flood plain, about 3 miles south of the City of Fairbanks water-supply wells. The landfill has been in operation for about 25 years in this sub-arctic region of discontinuous permafrost. The cold climate limits biological activity within the landfill with corresponding low gas and leachate production. Chloride concentrations, specific conductance, water temperatures, and earth conductivity measurements indicate a small plume of leachate flowing to the northwest from the landfill. The leachate remains near the water table as it flows northwestward toward a drainage ditch. Results of computer modeling of this local hydrologic system indicate that some of the leachate may be discharging to the ditch. Chemical data show that higher-than-background concentrations of several ions are present in the plume. However, the concentrations appear to be reduced to background levels within a short distance along the path of ground-water flow from the landfill, and thus the leachate is not expected to affect the water-supply wells. GRA

N91-25532 California Univ., San Diego.
MULTIPLE TAPER SPECTRAL ANALYSIS OF EARTH ROTATION DATA Ph.D. Thesis
Nancy Ellen King 1990 221 p
Avail: Univ. Microfilms Order No. DA9110705

The multiple taper method is optimal for bias control, and yields consistent estimates without section or band averaging. This method was applied to various length-of-day and polar motion data sets from optical, satellite laser ranging (SLR), and very long baseline interferometry (VLBI) techniques. The power spectrum was used to compare length of day data sets samples at different times. The NGS and GSFC reductions of IRIS VLBI data, the IRIS intensive VLBI data (filtered and decimated to 5 day samples), and the CSR SLR data (filtered and decimated to 6 day samples) are consistent with the same model power spectrum. However, the GSFC SLR and CDP VLBI data are not consistent with this model. When the CDP observations are removed from GSFC's data, coherence between the NGS and GSFC data improves and is 0.8 or higher for all frequencies. Lunar occultation length of day must be smoothed. Several data sets were used to construct a composite power spectrum for length of day. This spectrum bends between 1 and 5 cycles per year. The power spectrum of NMC atmospheric data has similar structure. For polar motion, the power spectrum of IRIS VLBI data lies about 15 dB below the ILS power spectrum at high frequencies. The retrograde annual wobble is much smaller in the space geodetic data, suggesting that the optical data is contaminated with an annual systematic error. Dissert. Abstr.

N91-25533*# Massachusetts Inst. of Tech., Cambridge. Dept. of Earth, Atmospheric, and Planetary Sciences.
THE INTERPRETATION OF CRUSTAL DYNAMICS DATA IN TERMS OF PLATE MOTIONS AND REGIONAL DEFORMATION NEAR PLATE BOUNDARIES Semiannual Status Report No. 9, 22 Sep. 1990 - 21 Mar. 1991
Sean C. Soloman 24 Jun. 1991 226 p
(Grant NAG5-814)
(NASA-CR-188500; NAS 1.26:188500) Avail: NTIS HC/MF A11 CSCL 08G

The focus of the research was in two broad areas: (1) the nature and dynamics of time dependent deformation and stress along major seismic zones; and (2) the nature of long wavelength oceanic geoid anomalies in terms of lateral variations in upper mantle temperature and composition. The principle findings of the research are described in the accompanying appendices. The first two and the fourth appendices are reprints of papers recently submitted for publication, and the third is the abstract of a recently completed thesis supported by this project. Author

N91-25534 Texas Univ. at Dallas, Richardson.
THE IONOSPHERIC SIGNATURES, SUBSTORM PHASE RELATIONSHIP, AND ELECTRODYNAMICS OF RAPID SUBAURORAL ION DRIFTS Ph.D. Thesis
Phillip Charles Anderson 1990 122 p
Avail: Univ. Microfilms Order No. DA9110767

Sub-auroral ion drifts (SAID) are latitudinally narrow regions of rapid westward drift located on the equatorward edge of the premidnight auroral oval. The magnitude of this drift can exceed 5000 m/s 250 mV/m. They are excellent examples of ionosphere-magnetic activity. The hot particle and pressure distributions in this region have an effect on the distribution of currents in the ionosphere-magnetosphere of the plasma sheet -- a region highly susceptible to magnetic activity. The hot particle and pressure distributions in this region have an effect on the distribution of currents in the ionosphere, where energetic particle precipitation produces large gradients in the conductivity. This is therefore a very dynamic region in which large scale electrodynamic features might be expected. In the region of the ionosphere where collisional physics is important, the rapid drift has profound effects on the ionospheric composition and thermal budget. The attempt here is to develop an understanding of the mechanism producing SAID through satellite measurements of ion drift, precipitating particles and the magnetic perturbations associated with ionospheric currents. The substorm relationship is examined with simultaneous observations of SAID in the ionosphere and images of the auroral luminosities associated with substorms. Observations of the effect SAID have on the ionospheric F-region chemistry and heat balance are reported. Dissert. Abstr.

N91-25535 Oregon Graduate Inst. of Science and Technology, Beaverton.
A STUDY OF ATMOSPHERIC N-ALKANES AND PAHs AND THEIR DISTRIBUTIONS BETWEEN THE GASEOUS AND PARTICULATE PHASES Ph.D. Thesis
Kenneth Michael Hart 1989 333 p
Avail: Univ. Microfilms Order No. DA9109516

The extent to which a compound is removed from the atmosphere and transported to other compartments depends in part on how that compound is distributed between the gaseous and particulate phases. Recent theoretical advances indicate that a compound's vapor pressure and the ambient temperature will play large roles in determining the extent to which the compound partitions to atmospheric particulate matter. However, the testing of such theory requires artifact free values of the gas and particulate phase concentrations. A field study designed to minimize sampling artifacts was conducted in Portland, OR during 1988. During this study, the concentrations of n-alkanes (C16 through C31) and eleven polynuclear aromatic hydrocarbons (PAHs) were measured in the gas and particulate phases over a range of ambient temperatures. Two air samplers were built to collect gas and particulate phase samples. One of the samplers utilized two quartz fiber filters (QFFs) in series and followed by two polyurethane foam sheets (PUFSs). The second sampler utilized a Teflon membrane filter (TMF) followed by a QFF and two PUFSs. Gas phase adsorption to the QFFs, as measured on the backup QFFs, was found to be a significant artifact for all of the more volatile n-alkanes as well as some of the PAHs studied. It was also determined that the QFF behind the TMF provided the best estimate of the extent of gas phase adsorption to the QFFs. Atmospheric partitioning was examined in the context of an equilibrium distribution constant K and a compound's temperature corrected subcooled liquid vapor pressure. The parameter K is defined as A(TSP)/F where A and F are the gas and particulate phase concentrations (ng/cu m) , respectively, and TSP is the total suspended particulate matter concentration (microg/cu m).
Dissert. Abstr.

N91-25536 Iowa State Univ. of Science and Technology, Ames.
ATMOSPHERIC OSCILLATIONS ON TIME SCALES OF 1-2 MONTHS Ph.D. Thesis
Jerald R. Ziemke 1990 140 p
Avail: Univ. Microfilms Order No. DA9110585

Low frequency oscillations in the troposphere and stratosphere on time scales of 1 to 2 months are observed in long time series of globally gridded temperature and geopotential height data. The stratosphere, rarely investigated for 1 to 2 month oscillations, is emphasized. A combination of statistics and dynamics is used to capture 3-D wave motion characteristics and the influence of 1 to 2 month oscillations in changing the stratospheric mean zonal wind. Observations are compared with several models encompassing 1 to 2 month time scales. Statistical significance was calculated in the power spectra of 1 to 2 month oscillations throughout the stratosphere from 90 to 1.5 hPa; the results support other studies which show that the oscillation is significant throughout much of the stratosphere, particularly in the Southern Hemisphere. A previous study that discovered an extratropical 35 to 60 day wavetrain in 200 hPa Southern Hemisphere geopotential heights was continued. Both troposphere and stratosphere are combined to substantiate the out then up conceptual picture. Using the statistics of correlation and coherence, the previously discovered 35 to 60 day 200 hPa wavetrain is shown to be statistically connected to the the Indian Ocean - western Pacific Ocean tropics.
Dissert. Abstr.

N91-25537# Danish Meteorological Inst., Copenhagen.
BRORFELDE GEOMAGNETIC OBSERVATORY MAGNETIC RESULTS 1988 - 1989
1991 31 p
(DMI-TR-91-3) Avail: NTIS HC/MF A03

Regular recording of the three geomagnetic elements D, H, and Z has taken place by means of a home-made digitally recording magnetometer system, GEMOS. The sensor system of GEMOS is based on commercial fluxgate elements. The following subjects areas are covered: instrumental equipment, determination of reduction formulas and baseline values, quality of data, yearbook processing, data distribution, comparison measurements, and baseline plots.
Author

N91-25538# Technische Univ., Delft (Netherlands). Faculty of Geodesy.
REPRESENTATIONS OF ROTATIONS AND TECTONIC PLATE MOTIONS Thesis
A. Jos M. Verheijen May 1990 167 p
(ETN-91-99419) Avail: NTIS HC/MF A08

A rotation can be represented by a 3 by 3 proper real orthogonal matrix, a 2 by 2 unimodular (complex) unitary matrix (spinor matrix), a normalized quaternion (rotation quaternion) and the geometric product of two unit vectors. The representation of a rotation by a quaternion has theoretical as well as computational advantages over the conventional matrix representation. It can be shown that spinor matrices correspond to quaternions. Accordingly, the parametrization of rotations by the Euler-Rodrigues parameters, which can be identified with quaternion components, has advantages over the common Euler angle parametrization. Some attention is further paid to the algebraic properties of spinors and the geometric product. Geometric algebra (Clifford algebra) integrates conventional vector algebra with quaternions. The matrix, spinor and quaternion representations are applied to the combinations of two rotations, coordinate transformations, infinitesimal rotations, differentiation of rotations and angular velocity vectors. Angular velocity vectors are used in plate tectonics to describe the motion of rigid plates. Alternative representations of tectonic plate motions are discussed, such as baseline/geodesic rates of change, absolute vector motions and finite element methods. The latter representation appears to be more appropriate to describe the tectonics of the Mediterranean area than the rigid microplate model. However, proceeding from rigid plate motion models, the expected baseline rates for the WEGENER/MEDLAS network are computed and discussed.
ESA

N91-25446*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
AIRBORNE LIDAR RESEARCH Abstract Only
S. Harvey Melfi *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 43 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 04A

N91-25447*# National Aeronautics and Space Administration, Washington, DC.
NASA 1990 MULTISENSOR AIRBORNE CAMPAIGNS (MACS) FOR ECOSYSTEM AND WATERSHED STUDIES
Diane E. Wickland, Ghassem Asrar, and Robert E. Murphy *In its* 4th Airborne Geoscience Workshop 1991 p 71-72 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 08H

N91-25452*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
GLOBAL BACKSCATTER EXPERIMENT (GLOBE) PACIFIC SURVEY MISSION
David A. Bowdle, Jeffry Rothermel, James E. Arnold, and Steven F. Williams (Alabama Univ., Huntsville.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 107-110 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 04A

N91-25470*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LIDAR MEASUREMENTS OF POLAR STRATOSPHERIC CLOUDS DURING THE 1989 AIRBORNE ARCTIC STRATOSPHERIC EXPEDITION
Syed Ismail and Edward V. Browell *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 181-182 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 04A

N91-25487*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
PROFILES OF ALPHA 13 C AND ALPHA D IN METHANE FROM THE LOWER STRATOSPHERE

Martin Wahlen, Nori Tanaka, Robert Henry (New York State Dept. of Environmental Conservation, Albany.), and Harley Weyer *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 285-286 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 13B

N91-25929*# West Virginia State Coll., Charleston. Dept. of Industrial Technology.
LOW FREQUENCY ELECTRIC AND MAGNETIC FIELDS
Abstract Only
Craig Spaniol *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 27 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 08G

47 METEOROLOGY AND CLIMATOLOGY

Includes weather forecasting and modification.

N91-25539# National Oceanographic Data Center, Washington, DC.
MARINERS WEATHER LOG, VOLUME 34, NUMBER 4, FALL, 1990 Quarterly Report
R. M. DeAngelis 1990 85 p
(PB91-124099) Avail: NTIS HC/MF A05 CSCL 04B

A number of topics relative to marine environments and marine navigation are discussed. Topics covered include an account of who put the wind speeds in Admiral Beaufort's force scale, the voyage of William Bligh, whale oil and wicks, a marine observation program, sea photography, radio officer tips, and ocean weather. Author

N91-25540# Scripps Institution of Oceanography, La Jolla, CA.
LARGE-SCALE OCEAN ATMOSPHERIC VARIABILITY ASSOCIATED WITH HYDROLOGICAL EXTREMES IN WESTERN NORTH AMERICA Final Report, Oct. 1987 - Sep. 1989
D. R. Cayan, J. O. Roads, and J. Namias 14 Jun. 1990 160 p Sponsored by US Geological Survey, Reston, VA
(Grant DI-14-08-0001-G-1483)
(PB91-159400; USGS/G-1483) Avail: NTIS HC/MF A08 CSCL 04B

Research in the project centered around the effects of Northern Hemisphere atmospheric circulation on precipitation and streamflow in North America from monthly to several year time scales and a diagnosis of numerical predictions of precipitation from the U.S. National Meteorological Center's medium and extended range model on weekly and monthly time scales. Monthly and seasonal Northern Hemisphere atmospheric flow patterns provided insight in diagnosing the great continental drought over the United States during the summer of 1988, effects of atmospheric anomalies on the record-breaking rise in the Great Salt Lake in 1981 to 1986, the effect of Pacific Ocean surface conditions and atmospheric circulation on streamflow variability and stream chemistry in western North America, and the identification of extreme southerly displaced North Pacific storms which cause flooding in the San Bernadino Mountains and the Mojave River watershed. To evaluate extended range precipitation forecasts (2 to 10 days lead), an extensive comparison of medium and extended range National Meteorological Center Model forecasts was made with observations. GRA

N91-25541# North Dakota Atmospheric Resource Board, Bismarck.
FEDERAL-STATE COOPERATIVE PROGRAM IN ATMOSPHERIC MODIFICATION RESEARCH, 1988 Final Report, Jul. 1988 - Dec. 1989
B. A. Boe and J. A. Jung 30 Mar. 1990 46 p Sponsored by National Oceanic and Atmospheric Administration, Rockville, MD
(Contract NA88-RAH-08115)
(PB91-141937) Avail: NTIS HC/MF A03 CSCL 04B

Obtaining the physical evidence which elucidates the cloud processes will ultimately determine the feasibility, efficacy, and potential of convective cloud seeding as an atmospheric resource management tool. While the efficacy of cloud seeding has long been debated, the ultimate resolution will be gained only when the physical cloud processes are understood. In the course of these investigations, basic research in cloud physics, atmospheric chemistry, storm dynamics, air pollution, severe storm forecasting, hydrology, and storm dynamics are conducted. The report is comprised of a brief review of the progress made under this cooperative agreement, with references to the technical reports, conference and journal articles published. GRA

N91-25542# National Weather Service, Washington, DC.
NATIONAL WEATHER SERVICE FIRE WEATHER PROGRAM USER INFORMATION
1990 28 p Sponsored in part by National Association of State Foresters, Washington, DC
(PB91-137844) Avail: NTIS HC/MF A03 CSCL 04B

The National Fire Weather Advisory Group (NFWAG) was charted in 1986 to provide coordination between the National Weather Service (NWS) and Federal and state fire weather user agencies. During the coordination process, users expressed a need for an NWS document that describes products and services available for fire weather and land management support. To fulfill that demand, NWS Western Region Meteorological Services Division developed a pamphlet to document some of the services currently available from the National Weather Service. The contents of the pamphlet should be helpful to anyone who provides or acts on weather information for forest and range land management. The pamphlet is organized into two sections; products and services of the National Weather Service, and an Appendix which describes fire weather forecast terminology and includes selected product examples. These services are provided by selected NWS offices throughout the United States. GRA

N91-25543# National Climatic Data Center, Asheville, NC.
JOINT US NAVY/US AIR FORCE CLIMATIC STUDY OF THE UPPER ATMOSPHERE. VOLUME 6: JUNE Final Report
Michael J. Changery, Claude N. Williams, Michael L. Dickenson, and Brian L. Wallace Nov. 1989 235 p
(AD-A232978; NAVAIR-50-1C-6) Avail: NTIS HC/MF A11 CSCL 04/2

This joint Navy and Air Force study of the upper atmosphere is based on 1980-85 twice daily gridded analysis produced by the European Centre for Medium Range Weather Forecasts. Included are global analyses of (1) mean atmospheric temperature/standard deviation, (2) mean geopotential height standard deviation, (3) mean density standard deviation, (4) height and vector standard deviation. All data are for 13 pressure levels (1000, 850, 700, 500, 300, 250, 200, 150, 100, 70, 50, and 30 mb). In addition, analysis of (5) mean dew point/standard deviation (levels 1000 through 300 mb), and (6) jet streams (mean scalar speed) (levels 500 through 30 mb), and global 5 degree grid point wind roses for the 13 pressure levels are included. GRA

N91-25544# National Climatic Data Center, Asheville, NC.
JOINT US NAVY/US AIR FORCE CLIMATIC STUDY OF THE UPPER ATMOSPHERE. VOLUME 8: AUGUST Final Report
Michael J. Changery, Claude N. Williams, Michael L. Dickenson, and Brian L. Wallace Sep. 1989 235 p
(AD-A232979; NAVAIR-50-1C-8) Avail: NTIS HC/MF A11 CSCL 04/2

This joint Navy and Air Force study of the upper atmosphere is based on 1980-85 twice daily gridded analysis produced by the European Centre for Medium Range Weather Forecasts. Included are global analyses of (1) mean atmospheric temperature/standard deviation, (2) mean geopotential height standard deviation, (3) mean density standard deviation, (4) height and vector standard deviation. All data are for 13 pressure levels (1000, 850, 700, 500, 300, 250, 200, 150, 100, 70, 50, 30 mb). In addition, analysis of (5) mean dew point/standard deivation (levels 1000 through 300 mb), and (6) jet streams (mean scalar speed) (levels 500 through 30 mb), and global 5 degree grid point wind roses for the 13 pressure levels are included. GRA

N91-25545# National Climatic Data Center, Asheville, NC.
JOINT US NAVY/US AIR FORCE CLIMATIC STUDY OF THE UPPER ATMOSPHERE. VOLUME 9: SEPTEMBER Final Report
Michael J. Changery, Claude N. Williams, Michael L. Dickenson, and Brian L. Wallace Nov. 1989 235 p
(AD-A232980; NAVAIR-50-1C-9) Avail: NTIS HC/MF A11 CSCL 04/2

This joint Navy and Air Force study of the upper atmosphere is based on 1980-85 twice daily gridded analysis produced by the European Centre for Medium Range Weather Forecasts. Included are global analyses of (1) mean atmospheric temperture/standard deviation, (2) mean geopotential height standard deviation, (3) mean density standard deviation, (4) height and vector standard deviation. All data are for 13 pressure levels (1000, 850, 700, 500, 300, 250, 200, 150, 100, 70, 50, and 30 mb). In addition, analysis of (5) mean dew point/standard deviation (levels 1000 through 300 mb), and (6) jet streams (mean scalar speed) (levels 500 through 30 mb), and global 4 degree grid point wind roses for the 13 pressure levels are included. GRA

N91-25546# National Climatic Data Center, Asheville, NC.
JOINT US NAVY/US AIR FORCE CLIMATIC STUDY OF THE UPPER ATMOSPHERE. VOLUME 11: NOVEMBER Final Report
Michael J. Changery, Claude N. Williams, Michael L. Dickenson, and Brian L. Wallace Sep. 1989 235 p
(AD-A232981; NAVAIR-50-1C-11) Avail: NTIS HC/MF A11 CSCL 04/2

This joint Navy and Air Force study of upper atmosphere is based on 1980-85 twice daily gridded analysis produced by the European Centre for Medium Range Weather Forecasts. Included are global analysis of (1) mean atmospheric temperature/standard deviation, (2) mean geopotential height standard deviation, (3) mean density standard deviation, (4) height and vector standard deviation. All data are for 13 pressure levels (1000, 850, 700, 500, 300, 250, 200, 150, 100, 70, 50, 30 mb). In addition, analysis of (5) mean dew point/standard deivation (levels 1000 through 300 mb), and (6) jet streams (mean scalar speed) (levels 500 through 30 mb), and global 5 degree grid point wind roses for the 13 pressure levels are included. GRA

N91-25547# National Climatic Data Center, Asheville, NC.
JOINT US NAVY/US AIR FORCE CLIMATIC STUDY OF THE UPPER ATMOSPHERE. VOLUME 12: DECEMBER Final Report
Michael J. Changery, Claude N. Williams, Michael L. Dickenson, and Brian L. Wallace Nov. 1989 235 p
(AD-A232982; NAVAIR-50-1C-12) Avail: NTIS HC/MF A11 CSCL 04/2

This joint Navy and Air Force study of the upper atmosphere is based on 1980-85 twice daily gridded analysis produced by the European Centre for Medium Range Weather Forecasts. Included are global analyses of (1) mean atmospheric temperature/standard deviation, (2) mean geopotential height standard deviation, (3) mean density standard deviation, (4) height and vector standard deviation. All data are for 13 pressure levels (1000, 850, 700, 500, 300, 250, 200, 150, 100, 70, 50, and 30 mb). In addition, analysis of (5) mean dew point/standard deviation (levels 1000 through 300 mb), and (6) jet streams (mean scalar speed) (levels 500 through 30 mb), and global 5 degree grid point wind roses for the 13 pressure levels are included. GRA

N91-25548*# Hughes Space and Communications Group, Los Angeles, CA. Government Electronics Systems Div.
HIGH RESOLUTION MICROWAVE SPECTROMETER SOUNDER (HIMSS) INSTRUMENT PROGRAM. APPENDIX: TRMM STUDY (AN INSTRUMENT FOR NASA'S TROPICAL RAINFALL MEASURING MISSION) Final Report
E. Lobl, ed. Apr. 1991 121 p
(Contract NAS8-38175)
(NASA-CR-184162; NAS 1.26:184162; HS256C-1045-0061-App) Avail: NTIS HC/MF A06 CSCL 04B

The TRMM (Tropical Rain Measuring Mission) Study shows the feasibility of a conically scanned, total power radiometer. The heritage of the TRMM radiometer is the Special Sensor Microwave/Imager (SSM/I) flying for the Air Force DMSP. Author

N91-25549*# Purdue Univ., West Lafayette, IN. Dept. of Earth and Atmospheric Sciences.
THE ROLE OF GLOBAL CLOUD CLIMATOLOGIES IN VALIDATING NUMERICAL MODELS Semiannual Status Report, 1 Oct. 1990 - 31 Mar. 1991
Harshvardhan 31 Mar. 1991 33 p
(Grant NAG5-1125)
(NASA-CR-188542; NAS 1.26:188542) Avail: NTIS HC/MF A03 CSCL 04B

Reliable estimates of the components of the surface radiation budget are important in studies of ocean-atmosphere interaction, land-atmosphere interaction, ocean circulation and in the validation of radiation schemes used in climate models. The methods currently under consideration must necessarily make certain assumptions regarding both the presence of clouds and their vertical extent. Because of the uncertainties in assumed cloudiness, all these methods involve perhaps unacceptable uncertainties. Here, a theoretical framework that avoids the explicit computation of cloud fraction and the location of cloud base in estimating the surface longwave radiation is presented. Estimates of the global surface downward fluxes and the oceanic surface net upward fluxes were made for four months (April, July, October and January) in 1985 to 1986. These estimates are based on a relationship between cloud radiative forcing at the top of the atmosphere and the surface obtained from a general circulation model. The radiation code is the version used in the UCLA/GLA general circulation model (GCM). The longwave cloud radiative forcing at the top of the atmosphere as obtained from Earth Radiation Budget Experiment (ERBE) measurements is used to compute the forcing at the surface by means of the GCM-derived relationship. This, along with clear-sky fluxes from the computations, yield maps of the downward longwave fluxes and net upward longwave fluxes at the surface. The calculated results are discussed and analyzed. The results are consistent with current meteorological knowledge and explainable on the basis of previous theoretical and observational works; therefore, it can be concluded that this method is applicable as one of the ways to obtain the surface longwave radiation fields from currently available satellite data. Author

N91-25550*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
ATMOSPHERIC ENVIRONMENT FOR SPACE SHUTTLE (STS-35) LAUNCH
G. L. Jasper and G. W. Batts (New Technology, Inc., Huntsville, AL.) Jun. 1991 46 p
(NASA-TM-103538; NAS 1.15:103538) Avail: NTIS HC/MF A03 CSCL 04B

A summary is given of selected atmospheric conditions observed near space shuttle STS-35 launch time on December 2, 1990, at Kennedy Space Center, Florida. Values of ambient pressure, temperature, moisture, ground winds, visual observations (cloud), and winds aloft are included. The sequence of prelaunch Jimsphere-measured vertical wind profiles is given in this report. The final atmospheric tape, which consists of wind and thermodynamic parameters versus altitude, for STS-35 vehicle ascent has been constructed. The STS-35 ascent atmospheric data tape has been constructed by Marshall Space Flight Center's Earth Science and Applications Division to provide an internally consistent data set for use in postflight performance assessments and represents the best estimate of the launch environment to the 400,000-ft altitude that was traversed by the STS-35 vehicle. Author

N91-25551 Washington Univ., Seattle.
MICROPHYSICAL, CHEMICAL AND METEOROLOGICAL ASPECTS OF AEROSOL HAZES IN THE ARCTIC Ph.D. Thesis
Charles Andrew Brock 1990 323 p
Avail: Univ. Microfilms Order No. DA9109786

A series of airborne field programs was conducted over

Greenland and the Alaskan and Canadian Arctic in spring 1983, summer 1985, and spring 1986 to examine the microphysical, chemical, and meteorological properties of pollution hazes in the Arctic. Measurements included aerosol size distributions, particle chemistry, concentrations of Aitken nuclei, and values of the light scattering coefficient. The expedition in 1986 included an airborne, downward pointing lidar operating at a wavelength of 1.064 microns. Analysis of the data revealed striking differences in the properties of arctic hazes measured in the spring and summer, as well as more minor differences between the two spring cases. The study showed that current conceptual models of arctic haze transport and distribution are inadequate. Dissert. Abstr.

N91-25552 Washington Univ., Seattle.
NUMERICAL SIMULATION OF EQUATORIAL EASTERLY WAVES FORCED BY CUMULUS CONVECTION Ph.D. Thesis
Xiaoli Zhu 1990 227 p
Avail: Univ. Microfilms Order No. DA9108545

A simple three layer numerical primitive equation model with spherical geometry in pressure coordinates is used to investigate the response of the atmosphere to a specified diabatic heating which has the major characteristics of the observed heating for westward propagating easterly wave disturbances in the equatorial region. The thermodynamic energy equation is simplified to a diagnostic equation. The specified diabatic heating consists of a zonally averaged portion and a deviation which traverses westward with a speed of about 10 m/s. It agrees with the observations that strong latent heat release from cumulus convection is concentrated in a small region, and outside this region there is a weak compensatory cooling. For the control run in which all the nonlinear terms are neglected and the atmosphere is initially assumed to be still, the total atmospheric response to the specified heating consists of a disturbance generated zonal mean and a deviation. The response, particularly the fluctuation of the meridional wind, is much stronger than in the observations. A meridionally varying basic state zonal flow can effectively reduce the amplitude of the model response close to the observations. The mean meridional wind, though rather weak, transports the zonal momentum of the basic state zonal flow between latitudes and diminishes the disturbance generated zonal mean wind. The perturbation meridional momentum is advected by the basic mean zonal wind and diminishes the amplitude of the meridional wind fluctuations and changes the wave structure as well. The nonlinear processes can bring the amplitude of the wave response back to the range of the observations with the way similar to that of the basic mean zonal wind but more effectively, since the structure of the model generated mean zonal wind is very similar to the specified, but with stronger lateral shear. The thermal damping due to radiative cooling effectively changes the model response both in amplitude and structure. It is nonlinear advection of the synoptic scale vorticity, not cumulus friction, that maintains the vorticity balance in the upper troposphere. Dissert. Abstr.

N91-25553*# FWG Associates, Inc., Tullahoma, TN.
GUIDE TO MEASUREMENT OF WINDS WITH INSTRUMENTED AIRCRAFT Final Report
Walter Frost, Terry S. Paige, and Andrew E. Nelius 25 Mar. 1991 89 p
(Contract NAS8-37893)
(NASA-CR-188601; NAS 1.26:188601) Avail: NTIS HC/MF A05 CSCL 04B

Aircraft measurement techniques are reviewed. Review of past and present applications of instrument aircraft to atmospheric observations is presented. Questions to be answered relative to measuring mean wind profiles as contrasted to turbulence measurements are then addressed. Requirements of instrumentation and accuracy, data reduction, data acquisition, and theoretical and certainty analysis are considered. Author

N91-25554*# Colorado State Univ., Fort Collins. Dept. of Atmospheric Science.
LINEAR AND NONLINEAR ASPECTS OF THE TROPICAL 30-60 DAY OSCILLATION: A MODELING STUDY Final Report, 3 Mar. 1989 - 28 Feb. 1991
Duane E. Stevens (Hawaii Univ., Manoa.) and Graeme L. Stephens 1991 102 p
(Grant NAG5-1122)
(NASA-CR-188607; NAS 1.26:188607) Avail: NTIS HC/MF A06 CSCL 04B

The scientific problem focused on study of the tropical 30-60 day oscillation and explanation for this phenomenon is discussed. The following subject areas are covered: the scientific problem (the importance of low frequency oscillations; suggested mechanisms for developing the tropical 30-60 day oscillation); proposed research and its objective; basic approach to research; and results (satellite data analysis and retrieval development; thermodynamic model of the oscillation; the 5-level GCM). Author

N91-25555*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
ANALYSIS OF LIGHTNING FIELD CHANGES PRODUCED BY FLORIDA THUNDERSTORMS
William John Koshak Apr. 1991 171 p
(NASA-TM-103539; NAS 1.15:103539) Avail: NTIS HC/MF A08 CSCL 04B

A new method is introduced for inferring the charges deposited in a lightning flash. Lightning-caused field changes (delta E's) are described by a more general volume charge distribution than is defined on a large cartesian grid system centered above the measuring networks. It is shown that a linear system of equations can be used to relate delta E's at the ground to the values of charge on this grid. It is possible to apply more general physical constraints to the charge solutions, and it is possible to access the information content of the delta E data. Computer-simulated delta E inversions show that the location and symmetry of the charge retrievals are usually consistent with the known test sources. Author

N91-25556*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
THE ROLE OF WATER VAPOR IN CLIMATE. A STRATEGIC RESEARCH PLAN FOR THE PROPOSED GEWEX WATER VAPOR PROJECT (GVaP)
D. OC. Starr, ed. and S. Harvey Melfi, ed. Washington Jul. 1991 54 p Workshop held in Easton, MD, 30 Oct. - 1 Nov. 1990; sponsored by NASA and the GEWEX Science Steering Group
(NASA-CP-3120; Rept-91B00108; NAS 1.55:3120) Avail: NTIS HC/MF A04 CSCL 04B

The proposed GEWEX Water Vapor Project (GVaP) addresses fundamental deficiencies in the present understanding of moist atmospheric processes and the role of water vapor in the global hydrologic cycle and climate. Inadequate knowledge of the distribution of atmospheric water vapor and its transport is a major impediment to progress in achieving a fuller understanding of various hydrologic processes and a capability for reliable assessment of potential climatic change on global and regional scales. GVap will promote significant improvements in knowledge of atmospheric water vapor and moist processes as well as in present capabilities to model these processes on global and regional scales. GVaP complements a number of ongoing and planned programs focused on various aspects of the hydrologic cycle. The goal of GVaP is to improve understanding of the role of water vapor in meteorological, hydrological, and climatological processes through improved knowledge of water vapor and its variability on all scales. A detailed description of the GVaP is presented. Author

N91-25557*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SATELLITE ORBIT CONSIDERATIONS FOR A GLOBAL CHANGE TECHNOLOGY ARCHITECTURE TRADE STUDY
Edwin F. Harrison, Gary G. Gibson, John T. Suttles, James J. Buglia, and Israel Taback (Bionetics Corp., Hampton, VA.) May 1991 18 p
(NASA-TM-104081; NAS 1.15:104081) Avail: NTIS HC/MF A03 CSCL 04B

A study was conducted to determine satellite orbits for earth observation missions aimed at obtaining data for assessing data global climate change. A multisatellite system is required to meet the scientific requirements for temporal coverage over the globe. The best system consists of four sun-synchronous satellites equally spaced in local time of equatorial crossing. This system can obtain data every three hours for all regions. Several other satellite systems consisting of combinations of sun-synchronous orbits and either the Space Station Freedom or a mid-altitude equatorial satellite can provide three to six hour temporal coverage, which is sufficient for measuring many of the parameters required for the global change monitoring mission. Geosynchronous satellites are required to study atmospheric and surface processes involving variations on the order of a few minutes to an hour. One or two geosynchronous satellites can be relocated in longitude to study processes over selected regions of earth. Author

N91-25558*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SCIENCE REQUIREMENTS FOR A GLOBAL CHANGE TECHNOLOGY ARCHITECTURE TRADE STUDY
John T. Suttles, Edwin F. Harrison, Gary G. Gibson (Lockheed Engineering and Sciences Co., Hampton, VA.), and Thomas G. Campbell May 1991 17 p
(NASA-TM-104082; NAS 1.15:104082) Avail: NTIS HC/MF A03 CSCL 04B

Science requirements for a global change technology initiative (GCTI) Architecture Trade Study were established by reviewing and synthesizing results from recent studies. A scientific rationale was adopted and used to identify a comprehensive set of measureables and their priorities. Spatial and temporal requirements for a number of measurement parameters were evaluated based on results from several working group studies. Science requirements were defined using these study results in conjunction with the guidelines for investigating global changes over a time scale of decades to centuries. Requirements are given separately for global studies and regional process studies. For global studies, temporal requirements are for sampling every 1 to 12 hours for atmospheric and radiation parameters and 1 day or more for most earth surface measurements. Therefore, the atmospheric measureables provide the most critical drivers for temporal sampling. Spatial sampling requirements vary from 1 km for land and ocean surface characteristics to 50 km for some atmospheric parameters. Thus, the land and ocean surface parameters have the more significant spatial variations and provide the most challenging spatial sampling requirements. Author

N91-25453*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
CALIBRATION OF THE ER-2 METEOROLOGICAL MEASUREMENT SYSTEM
Stuart W. Bowen (San Jose State Univ., CA.), K. Roland Chan, and T. Paul Bui *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 111-112 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 04B

N91-25457*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
APPLICATIONS OF THE ER-2 METEOROLOGICAL MEASUREMENT SYSTEM
K. Roland Chan, Leonhard Pfister, T. Paul Bui, Stuart W. Bowen, and Jonathan Dean-Day (San Jose State Univ., CA.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 125-126 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 04B

N91-25489*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
HIGH ALTITUDE AIRCRAFT DIRECTION USING REAL-TIME SCIENTIFIC ANALYSIS OF TELEMETERED DATA Abstract Only
Steven Wegener, K. Roland Chan, Leonhard Pfister, and John Arvesen *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 293-294 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 04B

48 OCEANOGRAPHY

Includes biological, dynamic, and physical oceanography; and marine resources.

For related information see also *43 Earth Resources and Remote Sensing.*

N91-25559# Nederlands Inst. voor Onderzoek der Zee, Texel.
JOINT GLOBAL OCEAN FLUX STUDY. NORTH ATLANTIC PILOT STUDY. LEG 3: DEN HELDER-FUNCHAL-REYKJAVIK, 17 APRIL TO 31 MAY 1990 WITH RESEARCH VESSEL TYRO
H. G. Fransz 1990 71 p Sponsored in part by Stichting Onderzoek der Zee, The Hague (Netherlands), and Nederlandse Organisatie voor Wetenschappelijk Onderzoek, The Hague (Netherlands)
(PB91-157479; NIOZ-1990-6; SOZ-CRUISE-1990-1) Avail: NTIS HC/MF A04 CSCL 08C

JGOFS (Joint Global Ocean Flux Study) leg 3 is part of the North Atlantic Pilot Study and is the second pelagic expedition within the national JGOFS program, with the aim to collect a data set for the spring situation in addition to the summer observations of 1989. To understand global change in atmospheric, oceanographic, and climatic conditions as effected by human activity, the fluxes of carbon must be measured and analyzed on a mondial scale. The pathways must be quantified and limiting factors in the production of organic matter, as well as the transport mechanisms must be understood in such a detail, that the dynamics of carbon and correlated elements in the biosphere such as plant nutrients can be simulated with mathematical models. JGOFS coordinates an international effort to create a databases based on standardized and intercalibrated methods of measurement in the oceans. A target area with main stations in the North Atlantic Ocean was chosen. The cruise contributed to the collection of information on carbon compartments, primary and secondary production, biomass distribution and species composition of algae, bacteria, and zooplankton in relation to the horizontal and vertical variation of nutrients and physics. GRA

N91-25560 California Univ., San Diego.
ARRAY MEASUREMENTS OF SURFACE GRAVITY WAVES Ph.D. Thesis
Thomas H. C. Herbers 1990 127 p
Avail: Univ. Microfilms Order No. DA9110701

Local properties of natural, wind generated, surface gravity waves are examined with arrays of pressure transducers. An estimator for wave radiation stresses and energy fluxes is derived, applicable to an array of 4 pressure transducers arranged in a square. The technique is based on an expansion for small kL with k the wave length and L the sensor separation. A variational method for estimating directional wave spectra, applicable to arbitrary array geometries in constant or slowly varying depth water is presented. A smooth estimate of the directional distribution of wave energy S(theta) is obtained by minimizing a roughness measure of the form the integral of d(theta) (d(exp 2) S(theta)/d(theta) (exp2)) squared subject to the constraints: (1) S(theta) is nonnegative, (2) S(theta) fits the data within a statistical confidence level, and (3) S(theta) is zero on directional sectors

where energy levels are always low because of geographic surroundings. Observations of sea floor pressure fluctuations in 13 m depth are compared to a theory for weakly nonlinear surface gravity waves (Hasselmann, 1962). Nonlinear interactions between directionally opposing seas theoretically excite long wavelength, double sea frequency forced waves that are only weakly attenuated at the sea floor. Dissert. Abstr.

N91-25561# Proudman Oceanographic Lab., Birkenhead (England).
CURRENT METER RECORDS. SITE F: 52 DEGREES 37 MINUTES N, 03 DEGREES 46 MINUTES E. AUGUST 1988 - SEPTEMBER 1989. NORTH SEA PROJECT
P. J. Knight, J. Falconer, and M. J. Howarth 1990 158 p
(Rept-11-1990; ETN-91-99469) Avail: NTIS HC/MF A08; Proudman Oceanographic Lab, The Library, Bidston Observvatory, Birkenhead, Merseyside L43 7RA, England, HC 46 Sterling pounds

Results from a current meter rig positioned at site F during the North Sea project are described. Site F was one of six current meter sites used throughout the survey part of the experiment. Standard plots are shown as well as statistical output from the calibrated current meter records. ESA

N91-25562# Proudman Oceanographic Lab., Birkenhead (England).
CURRENT METER RECORDS. SITE E: 52 DEGREES 43 MINUTES N, 02 DEGREES 25 MINUTES E. AUGUST 1988 - SEPTEMBER 1989. NORTH SEA PROJECT
P. J. Knight, J. Falconer, and M. J. Howarth 1990 205 p
(Rept-12-1990; ETN-91-99470) Avail: NTIS HC/MF A10; Proudman Oceanographic Lab., The Library, Bidston Observatory, Birkenhead, Merseyside L43 7RA, England, HC 46 Sterling pounds

Results from a current meter rig positioned at site E during the North Sea project are described. Site E was one of six current meter sites used throughout the survey part of the experiment. Standard plots are shown as well as statistical output from the calibrated current meter records. ESA

N91-25563# Proudman Oceanographic Lab., Birkenhead (England).
CURRENT METER RECORDS. SITE B: 55 DEGREES 30 MINUTES N, 05 DEGREES 31 MINUTES E. AUGUST 1988 - SEPTEMBER 1989. NORTH SEA PROJECT
P. J. Knight, J. Falconer, and M. J. Howarth 1990 205 p
(Rept-13-1990; ETN-91-99471) Avail: NTIS HC/MF A10; Proudman Oceanographic Lab., The Library, Bidston Observatory, Birkenhead, Merseyside L43 7RA, England, HC 46 Sterling pounds

Results form a current meter rig positioned at site B during the North Sea project are described. Site B was one of six current meter sites used throughput the survey part of the experiment. Standard plots are shown as well as statistical output from the calibrated current meter records. ESA

N91-25564# North Carolina State Univ., Raleigh. Dept. of Marine, Earth and Atmospheric Sciences.
SHELF EXPORT OF PARTICULATES/TRANSPORT IN CONTINENTAL MARGIN WATERS
L. J. Pietrafesa Feb. 1991 45 p
(Contract DE-FG09-85ER-60376)
(DE91-011030; DOE/ER-60376/5) Avail: NTIS HC/MF A03

SEEP-II is a sponsored multi-institutional, multi-disciplinary program designed to address the possibility of flux material along and across the Mid-Atlantic Bight (MAB). The methodology in SEEP-II employed conventional taut-wire moorings surrounding four RD acoustic doppler profiling current meters along with biological sampling of the source term of the biogenic material and the geochemical measurement of sedimentation rates. The field program was 17 months in length, from February 1988 to June 1989, located off the Delaware and Chesapeake Bays. The SEEP-II moored array consists of two main cross shelf arrays the northern of which had 6 to 8 moorings spanning the 40 to 1,000 m isobaths with one (and in Phase 2, a second) mooring offset about 20 km downshelf at 90 m (and in Phase 2, a mooring also at 40 m). The basic schematics of the northern and southern arrays are shown. In the region where the MAB shelf water/slope water front intersects the bottom, four RD-ADCP's were the focus of the array. Each of the bottom mounted profilers was accompanied by thermister strings (chains), Aanderaa current meters, fluorometers and transmissometers. DOE

N91-25565# Brookhaven National Lab., Upton, NY.
OCEAN SURVEY OF INORGANIC CARBON
K. M. Johnson 25 Apr. 1991 6 p
(Contract DE-AC02-76CH-00016)
(DE91-011130; BNL-44235) Avail: NTIS HC/MF A02

Measurements were made aboard the F.S. Meteor, along the 19 deg South cruise track of the following chemical parameters: total dissolved inorganic carbon, pH, pCO2, CFC-12, CFC-11, CFC-113, CC14. This was the first cruise of OASD's newly formed CO2 group. The purpose was to survey World Ocean Circulation Experiment (WOCE) line A9 for inorganic carbon for the Department of Energy's Office of CO2 Research. DOE

N91-25454*# National Aeronautics and Space Administration. John C. Stennis Space Center, Bay Saint Louis, MS.
AIR DEPLOYED EXPENDABLE PROBES IN OCEANOGRAPHIC RESEARCH Abstract Only
Janice D. Boyd *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 113 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 08C

N91-25478*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
THE SURFACE WAVE DYNAMICS EXPERIMENT (SWADE) Abstract Only
Erik Mollo-Christensen and J. David Oberholtzer (National Aeronautics and Space Administration. Wallops Flight Facility, Wallops Island, VA.) *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 219-222 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 08C

N91-25919*# Florida State Univ., Tallahassee. Dept. of Oceanography.
CONTINENTAL SHELF FISH PRODUCTION ESTIMATION FROM CZCS CHLOROPHYLL DATA Abstract Only
Richard L. Iverson *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 15 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 08C

N91-25925*# Murray State Univ., KY. Dept. of Physics.
SPECTRAL CALIBRATION ANALYSIS OF THE AIRBORNE OCEANOGRAPHIC LIDAR Abstract Only
Carlton E. Rousey *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 23 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 08C

51 LIFE SCIENCES (GENERAL)

N91-25566# Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H., Vienna. Hauptabt. fuer Strahlenschutz.
Cs-137 SOIL TO PLANT TRANSFER STUDIES AND THEIR IMPLICATIONS ON PARAMETERS USED IN THE AUSTRIAN VERSION OF ECOSYS
Martin H. Gerzabek, Othmar Horak, and Konrad Mueck Nov. 1990 11 p Presented at EC-Workshop on Transfer of

Radionuclides in Natural and Semi-Natural Environments, Passariano, Italy, 11-15 Sep. 1989 Submitted for publication Sponsored by Austrian Ministry of Science and Research
(OEFZS-4563; ETN-91-99494) Copyright Avail: NTIS HC/MF A03

In 1987 and 1988 102 Cs-soil to plant transfer data were determined in the field for various crop plants. The obtained mean values range from 0.0004 (zucchini, cauliflower) to 0.059 (rye straw). In addition to the significant influence of plant species on the transfer value, great differences between vegetative and generative parts were observed. The Cs-transfer into grains of cereals was 1.6, 1.8, 4.2 and 10.5 times lower than into straw of rye, barley, wheat and corn, respectively. The activity ratio between potato tops and tubers was 5.0. Multiple logarithmic correlation analysis proved the Cs-concentration of the soil to have the highest influence on the Cs-transfer as compared to physical and chemical soil properties. Therefore, the Cs-transfer seems not to be a constant for different fallout levels. On pasture a significant negative correlation between the potassium supply and Cs-uptake into grass was obtained. Data on transfer parameters used for the Austrian version of the radioecological model ECOSYS 87 are presented and discussed. ESA

N91-25567# Oak Ridge National Lab., TN.
NON-DESTRUCTIVE MONITORING OF MICROBIAL BIOFILMS AT SOLID-LIQUID INTERFACES USING ON-LINE DEVICES
D. E. Nivens, J. Q. Chambers, and D. C. White (Tennessee Univ., Knoxville.) 1990 12 p Presented at the International Congress on Microbially Influenced Corrosion, Knoxville, 7-12 Oct. 1990
(Contract DE-AC05-84OR-21400)
(DE91-010777; CONF-9010138-3) Avail: NTIS HC/MF A03

Corrosion, biofouling, and related problems have been an impetus for investigating interactions between microorganisms and solid surfaces. In recent years, a number of studies have been performed to assess the damages caused by microbial influenced corrosion (MIC). In a number of these studies, electrochemical techniques have monitored the performance of metal surfaces exposed to bacteria. However, most of these methods can only indirectly detect the presence of biofilms. In this paper, two non-destructive on-line monitoring devices, attenuated total reflection Fourier transform infrared spectroscopy (ATR-FT/IR) and the quartz crystal microbalance (QCM) were used to directly monitor biofilm formation. These devices have been developed to study the initial fouling process and subsequent biofilm development and not merely the effects of the living film on the host material. The ATR-FT/IR technique provides information about biomass, exopolymer production, and the nutritional status of microbial biofilms. The QCM provides a direct measure of biomass. ATR-FT/IR and QCM detect 10(exp 6) and 10(exp 4) Caulobacter crescentus cells/sq cm, respectively. Both techniques can be coupled with electrochemical methods for deeper insight into mechanisms of MIC. DOE

N91-25568# Mount Sinai School of Medicine, New York, NY.
MOLECULAR MECHANISMS IN RADIATION DAMAGE TO DNA
R. Osman 1990 29 p
(Contract DE-FG02-88ER-60675)
(DE91-010922; DOE/ER-60675/T2) Avail: NTIS HC/MF A03

This study concentrated on two major directions. One was to investigate the formation and the properties of sugar and base radicals with quantum mechanical methods. The other was to explore with molecular dynamics simulations the conformational properties of radiation damaged DNA. Details of the findings highlight the approaches taken and identify the major contributions to the understanding of molecular processes in the development of biological consequences of the depositions of radiation energy in DNA. DOE

N91-25569# Georgia Univ., Athens. Dept. of Biochemistry.
THE METABOLISM OF HYDROGEN BY EXTREMELY THERMOPHILIC BACTERIA
M. W. W. Adams 1991 9 p
(Contract DE-FG09-88ER-13901)
(DE91-011031; DOE/ER-13901/3) Avail: NTIS HC/MF A02

The novel archaebacterium, Pyrococcus furiosus, grows optimally at 100 C by a fermentative metabolism and produces hydrogen (H2). This organism appears to ferment glucose and evolve H2 by a novel pathway. The following metalloenzymes and proteins involved in H2 metabolism were purified and characterized: hydrogenase (NiFeS), ferredoxin (FeS), pyruvate ferredoxin oxidoreductase (FeS), and an new enzyme which contains tungsten, glyceraldehyde ferredoxin oxidoreductase (WFeS). A rubredoxin was also purified, and it and the ferredoxin have been sequenced. In addition, a second new enzyme was identified, glucose ferredoxin oxidoreductase. These represent the first enzymes and proteins to be purified from any organism able to grow optimally above 90 C. All are remarkably thermostable and show maximal catalytic activity greater than 95 C. The ferredoxin has several unique properties and is potentially an extremely thermostable model for the catalytic sites of a variety of mesophilic metalloenzymes. In addition, the FeS-containing enzymes, hydrogenase and pyruvate ferredoxin oxidoreductase, and a ferredoxin, have been purified from the most thermophilic eubacterium currently known, Thermotoga maritima. This organism grows up to 90 C, also by fermentation. The hydrogenases of T. maritima and P. furiosus each have many unique properties in comparison with mesophilic hydrogenases, and both appear to contain new types of metal centers that are specifically adapted to catalyze H2 production at the extreme temperatures. Hydrogenase activity has also been measured in four other extremely thermophilic organisms, one of which is capable of growth at 120 C. DOE

N91-25570*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
REGENERABLE BIOCIDE DELIVERY UNIT Patent Application
Gerald V. Colombo, inventor (to NASA), Clifford D. Jolly, inventor (to NASA) (Umpqua Research Co., Myrtle Creek, OR.), and Richard L. Sauer, inventor (to NASA) 18 Mar. 1991 18 p
(NASA-Case-MSC-21763-1; NAS 1.71:MSC-21763-1; US-Patent-Appl-SN-671603) Avail: NTIS HC/MF A03 CSCL 06K

A method and apparatus are disclosed for maintaining continuous, long-term microbial control in the water supply for potable, hygiene, and experimental water for space activities, as well as treatment of water supplies on Earth. The water purification is accomplished by introduction of molecular iodine into the water supply to impart a desired iodine residual. The water is passed through an iodinated anion exchange resin bed. The iodine is bound as I(sub n) at the anion exchange sites and releases I(sub 2) into the water stream flowing through the bed. The concentration of I(sub 2) in the flowing water gradually decreases and, in the prior art, the ion-exchange bed has had to be replaced. In a preferred embodiment, a bed of iodine crystals is provided with connections for flowing water therethrough to produce a concentrated (substantially saturated) aqueous iodine solution which is passed through the iodinated resin bed to recharge the bed with bound iodine. The bed of iodine crystals is connected in parallel with the iodinated resin bed and is activated periodically (e.g., by timer, by measured flow of water, or by iodine residual level) to recharge the bed. Novelty resides in the capability of inexpensively and repeatedly regenerating the ion-exchange bed in situ. NASA

N91-25581*# Eastern Virginia Medical School,. Norfolk. Dept. of Pathology.
JELLYFISH: SPECIAL TOOLS FOR BIOLOGICAL RESEARCH ON EARTH AND IN SPACE
Dorothy B. Spangenberg *In* NASA. Lyndon B. Johnson Space Center, Spacelab Life Sciences 1: Reprints of Background Life Sciences Publications May 1991 p 272-273 (For primary document see N91-25571 17-52)
Avail: NTIS HC/MF A18 CSCL 06E

N91-25582*# Eastern Virginia Medical School,. Norfolk. Dept. of Pathology.
EFFECTS OF CLINOSTAT ROTATION ON AURELIA STATOLITH SYNTHESIS
Dorothy B. Spangenberg, S. Davis, and H. Ross-Clunis, III *In* NASA. Lyndon B. Johnson Space Center, Spacelab Life Sciences 1: Reprints of Background Life Sciences Publications May 1991 p 274-275 (For primary document see N91-25571 17-52)
(Grant NAG2-243)
Avail: NTIS HC/MF A18 CSCL 06C

52 AEROSPACE MEDICINE

Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.

N91-25571*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
SPACELAB LIFE SCIENCES 1: REPRINTS OF BACKGROUND LIFE SCIENCES PUBLICATIONS
Ronald White, ed. and Joel I. Leonard, ed. (Lockheed Engineering and Sciences Co., Washington, DC.) May 1991 412 p Prepared in cooperation with GE, Houston, Tx
(NASA-TM-104962; NAS 1.15:104962) Avail: NTIS HC/MF A18 CSCL 06E

The research being conducted on SLS-1 is primarily concerned with the short-term adaptation of physiological systems to weightlessness. A comprehensive overview of the various disciplines being studied on SLS-1 is presented. Citations and abstracts of all the papers submitted by the SLS-1 investigator teams are contained. The physiological systems studied include: cardiovascular and cardiopulmonary, musculoskeletal, neurovestibular, renal and endocrine, hematological, and immunological. For individual titles, see N91-25572 through N91-25587.

N91-25572*# California Univ., San Francisco. Dept. of Medicine.
THE ROLE OF CALCIUM IN OSTEOPOROSIS
C. D. Arnaud and S. D. Sanchez *In* NASA. Lyndon B. Johnson Space Center, Spacelab Life Sciences 1: Reprints of Background Life Sciences Publications May 1991 p 3-20 (For primary document see N91-25571 17-52)
Avail: NTIS HC/MF A18 CSCL 06E

Calcium requirements may vary throughout the lifespan. During the growth years and up to age 25 to 30, it is important to maximize dietary intake of calcium to maintain positive calcium balance and achieve peak bone mass, thereby possibly decreasing the risk of fracture when bone is subsequently lost. Calcium intake need not be greater than 800 mg/day during the relatively short period of time between the end of bone building and the onset of bone loss (30 to 40 years). Starting at age 40 to 50, both men and women lose bone slowly, but women lose bone more rapidly around the menopause and for about 10 years after. Intestinal calcium absorption and the ability to adapt to low calcium diets are impaired in many postmenopausal women and elderly persons owing to a suspected functional or absolute decrease in the ability of the kidney to produce 1,25(OH)2D2. The bones then become more and more a source of calcium to maintain critical extracellular fluid calcium levels. Excessive dietary intake of protein and fiber may induce significant negative calcium balance and thus increase dietary calcium requirements. Generally, the strongest risk factors for osteoporosis are uncontrollable (e.g., sex, age, and race) or less controllable (e.g., disease and medications). However, several factors such as diet, physical activity, cigarette smoking, and alcohol use are lifestyle related and can be modified to help reduce the risk of osteoporosis. Author

N91-25573*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
GRAVITY, CALCIUM, AND BONE: UPDATE, 1989
Sara B. Arnaud and Emily Morey-Holton *In* NASA. Lyndon B. Johnson Space Center, Spacelab Life Sciences 1: Reprints of Background Life Sciences Publications May 1991 p 21-44 (For primary document see N91-25571 17-52)
Avail: NTIS HC/MF A18 CSCL 06E

Some of the results of recent short-term flights and ground-based experiments that have contributed new insights into skeletal adaptation, calcium metabolism, and growth processes in 0 g, are highlighted. After 6 months in space, bone demineralization, invariably involving the os calcis, was found not to extend to the lumbar spine in 4 exercising cosmonauts. A flight experiment in the Space Shuttle crew has documented the early events in the calcium endocrine system during spaceflight. On the ground, brief and long-term bed rest studies of healthy volunteers in the head-down tile (HDT) model of weightlessness were completed. The skeleton of the adult male responds more rapidly to unloading than previously recognized. Regional changes in bone density can be quantified in only 30 days, are highly individual, and follow the direction of gravitational forces in the HDT model during inactivity. Bone biopsy results in healthy volunteers after bed rest differ from results in paraplegics from the same sampling site. Flight experiments in growing rats reveal changes in the composition of bone mineral and matrix in the femur postflight that were found to be highly regional and suggestive of an effect of gravity on mineral distribution. These observations may be relevant to the results from an earlier Cosmos flight where artificial gravity in space was found to maintain bone strength, but not to correct the radial growth deficit. Author

N91-25574*# Texas Univ., Dallas. Dept. of Internal Medicine.
CARDIOVASCULAR ADJUSTMENTS TO GRAVITATIONAL STRESS
C. Gunnar Blomqvist and H. Lowell Stone (Oklahoma Univ., Norman.) *In* NASA. Lyndon B. Johnson Space Center, Spacelab Life Sciences 1: Reprints of Background Life Sciences Publications May 1991 p 49-87 (For primary document see N91-25571 17-52)
Avail: NTIS HC/MF A18 CSCL 06E

The effects of gravity on the cardiovascular system must be taken into account whenever a hemodynamic assessment is made. All intravascular pressure have a gravity-dependent hydrostatic component. The interaction between the gravitational field, the position of the body, and the functional characteristics of the blood vessels determines the distribution of intravascular volume. In turn this distribution largely determines cardiac pump function. Multiple control mechanisms are activated to preserve optimal tissue perfusion when the magnitude of the gravitational field or its direction relative to the body changes. Humans are particularly sensitive to such changes because of the combination of their normally erect posture and the large body mass and blood volume below the level of the heart. Current aerospace technology also exposes human subjects to extreme variations in the gravitational forces that range from zero during space travel to as much an nine-times normal during operation of high-performance military aircraft. This chapter therefore emphasizes human physiology. Author

N91-25575*# State Univ. of New York, Buffalo. Dept. of Physiology.
EXPOSURE TO STRESSFUL ENVIRONMENTS: STRATEGY OF ADAPTIVE RESPONSES
Leon E. Farhi *In* NASA. Lyndon B. Johnson Space Center, Spacelab Life Sciences 1: Reprints of Background Life Sciences Publications 121-134 (SEE N91-25571 17-52) May 1991 (For primary document see N91-25571 17-52)
Avail: NTIS HC/MF A18 CSCL 06E

Any new natural environment may generate a number of stresses (such as hypoxia, water lack, and heat exposure), each of which can produce strains in more than a single organ system. Every strain may in turn stimulate the body to adapt in multiple ways. Nevertheless, a general strategy of the various adaptive responses emerges when the challenges are divided into three groups. The first category includes conditions that affect the supply of essential molecules, while the second is made up by those

stresses that prevent the body from regulating properly the output of waste products, such as CO2 and heat. In both classes, there is a small number of responses, similar in principle, regardless of the specific situation. The third unit is created by environments that disrupt body transport systems. Problems may arise when there is a conflict between two stresses requiring conflicting adaptive changes. An alternative to adaptation, creation of micro-environment, is often favored by the animal. Author

N91-25576*# California Univ., San Diego, La Jolla.
HEART-LUNG INTERACTIONS IN AEROSPACE MEDICINE
Harold J. B. Guy and Gordon Kim Prisk *In* NASA. Lyndon B. Johnson Space Center, Spacelab Life Sciences 1: Reprints of Background Life Sciences Publications May 1991 p 149-193 (For primary document see N91-25571 17-52)
Avail: NTIS HC/MF A18 CSCL 06E

Few of the heart-lung interactions that are discussed have been studied in any detail in the aerospace environment, but is seems that many such interactions must occur in the setting of altered accelerative loadings and pressure breathing. That few investigations are in progress suggests that clinical and academic laboratory investigators and aerospace organizations are further apart than during the pioneering work on pressure breathing and acceleration tolerance in the 1940s. The purpose is to reintroduce some of the perennial problems of aviation physiology as well as some newer aerospace concerns that may be of interest. Many possible heart-lung interactions are pondered, by necessity often drawing on data from within the aviation field, collected before the modern understanding of these interactions developed, or on recent laboratory data that may not be strictly applicable. In the field of zero-gravity effects, speculation inevitably outruns the sparse available data. Author

N91-25577*# Sydney Univ. (Australia). Dept. of Physiology.
THREE HIERARCHIES IN SKELETAL MUSCLE FIBRE CLASSIFICATION ALLOTYPE, ISOTYPE AND PHENOTYPE
Joseph F. Y. Hoh, Suzanne Hughes, Gregory Hugh, and Irene Pozgaj *In* NASA. Lyndon B. Johnson Space Center, Spacelab Life Sciences 1: Reprints of Background Life Sciences Publications May 1991 p 194-205 (For primary document see N91-25571 17-52)
Avail: NTIS HC/MF A18 CSCL 06E

Immunocytochemical analyses using specific anti-myosin antibodies of mammalian muscle fibers during regeneration, development, and after denervation have revealed two distinct myogenic components determining fiber phenotype. The jaw-closing muscles of the cat contain superfast fibers which express a unique myosin not found in limb muscles. When superfast muscle is transplanted into a limb muscle bed, regenerating myotubes synthesize superfast myosin independent of innervation. Reinnervation by the nerve to a fast muscle leads to the expression of superfast and not fast myosin, while reinnervation by the nerve to a slow muscle leads to the expression of a slow myosin. When limb muscle is transplanted into the jaw muscle bed, only limb myosins are synthesized. Thus jaw and limb muscles belong to distinct allotypes, each with a unique range of phenotype options, the expressions of which may be modulated by the nerve. Primary and secondary myotubes in developing jaw and limb muscles are observed to belong to different categories characterized by different patterns of myosin gene expression. By taking into consideration the pattern of myosins synthesized and the changes in fiber size after denervation, 3 types of primary (fast, slow, and intermediate) fibers can be distinguished in rat fast limb muscles. All primaries synthesize slow myosin soon after their formation, but this is withdrawn in fast and intermediate primaries at different times. After neonatal denervation, slow and intermediate primaries express slow primaries hypertrophy with other fibers atrophy. In the mature rat, the number of slow fibers in the EDL is less than the number of slow primaries. Upon denervation, hypertrophic slow fibers matching the number and topographic distribution of slow primaries appear, suggesting that a subpopulation of the slow primaries acquire the fast phenotype during adult life, but reveal their original identity as slow primaries in response to denervation by hypertrophying and synthesizing slow myosin. It is proposed that within each muscle allotype, the various isotypes of primary and secondary fibers are myogenically determined, and are derived from different lineage of myoblasts. Author

N91-25578*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
EFFECTS OF WEIGHTLESSNESS ON HUMAN FLUID AND ELECTROLYTE PHYSIOLOGY
Carolyn S. Leach and Philip C. Johnson, Jr. *In its* Spacelab Life Sciences 1: Reprints of Background Life Sciences Publications May 1991 p 210-218 (For primary document see N91-25571 17-52)
Avail: NTIS HC/MF A18 CSCL 06E

The changes that occur in human fluid and electrolyte physiology during the acute and adaptive phases of adaptation to spaceflight are summarized. A number of questions remain to be answered. At a time when plasma volume and extracellular fluid volume are contracted and salt and water intake is unrestricted. ADH does not correct the volume deficit and serum sodium decreases. Change in secretion or activity of a natriuretic factor during spaceflight is one possible explanation. Recent identification of a polypeptide hormone produced in cardiac muscle cells which is natiuretic, is hypotensive, and has an inhibitory effect on renin and aldosterone secretion has renewed interest in the role of a natriuretic factor. The role of this atrial natriuretic factor (ANF) in both long- and short-term variation in extracellular volumes and in the inability of the kidney to bring about an escape from the sodium-retaining state accompanying chronic cardiac dysfunction makes it reasonable to look for a role of ANF in the regulation of sodium during exposure to microgravity. Prostaglandin-E is another hormone that may antagonize the action of ADH. Assays of these hormones will be performed on samples from crew members in the future. Author

N91-25579*# State Univ. of New York, Buffalo. Dept. of Physiology.
GRAVITATIONAL FORCE AND THE CARDIOVASCULAR SYSTEM
D. R. Pendergast, A. J. Olszowka, M. A. Rokitka, and L. E. Farhi *In* NASA. Lyndon B. Johnson Space Center, Spacelab Life Sciences 1: Reprints of Background Life Sciences Publications May 1991 p 242-253 (For primary document see N91-25571 17-52)
(Contract NAS9-16042)
Avail: NTIS HC/MF A18 CSCL 06E

Cardiovascular responses to changes in gravitational force are considered. Man is ideally suited to his 1-g environment. Although cardiovascular adjustments are required to accommodate to postural changes and exercise, these are fully accomplished for short periods (min). More challenging stresses are those of short-term microgravity (h) and long-term microgravity (days) and of gravitational forces greater than that of Earth. The latter can be simulated in the laboratory and quantitative studies can be conducted. Author

N91-25580*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
MACULAR BIOACCELEROMETERS ON EARTH AND IN SPACE
M. D. Ross, L. Cutler, G. Meyer, P. Vazin, and T. Lam (Sterling Federal Systems, Inc., Palo Alto, CA.) *In* NASA. Lyndon B. Johnson Space Center, Spacelab Life Sciences 1: Reprints of Background Life Sciences Publications May 1991 p 261-271 (For primary document see N91-25571 17-52)
Avail: NTIS HC/MF A18 CSCL 06E

Space flight offers the opportunity to study linear bioaccelerometers (vestibular maculas) in the virtual absence of a primary stimulus, gravitational acceleration. Macular research in space is particularly important to NASA because the bioaccelerometers are proving to be weighted neural networks in which information is distributed for parallel processing. Neural networks are plastic and highly adaptive to new environments.

Combined morphological-physiological studies of maculas fixed in space and following flight should reveal macular adaptive responses to microgravity, and their time-course. Ground-based research, already begun, using computer-assisted, 3-dimensional reconstruction of macular terminal fields will lead to development of computer models of functioning maculas. This research should continue in conjunction with physiological studies, including work with multichannel electrodes. The results of such a combined effort could usher in a new era in understanding vestibular function on Earth and in space. They can also provide a rational basis for counter-measures to space motion sickness, which may prove troublesome as space voyager encounter new gravitational fields on planets, or must re-adapt to 1 g upon return to earth. Author

N91-25581*# Eastern Virginia Medical School,. Norfolk. Dept. of Pathology.

JELLYFISH: SPECIAL TOOLS FOR BIOLOGICAL RESEARCH ON EARTH AND IN SPACE **c51**

Dorothy B. Spangenberg *In* NASA. Lyndon B. Johnson Space Center, Spacelab Life Sciences 1: Reprints of Background Life Sciences Publications May 1991 p 272-273 (For primary document see N91-25571 17-52)

Avail: NTIS HC/MF A18 CSCL 06E

The most intriguing nature of the jellyfish polyps is their ability to metamorphose, giving rise to tiny immature medusae called ephyrae which have a different form or shape from the polyps. The Aurelia Metamorphosis Test System was used to determine the subtle effects of hydrocarbons found in oil spills and the effects of X-irradiation on developing ephyrae. Currently, this test system is used to determine the effects of the gravity-less environment of outer space on the development and behavior of ephyrae. For this purpose, the effects of clinostat rotation on development of the ephyrae and their gravity receptor are being studied. The behavior of the ephyrae during 0 gravity achieved for short intervals of 30 seconds in parabolic flight is examined. The developing ephyrae and the mature ephyrae are exposed to gravity-less environment of outer space via a six or seven day shuttle experiment. If gravity receptors do form in outer space, they will be studied in detail using various types of microscopes, including the electron microscope, to determin whether they developed normally in space as compared with control on Earth. B.G.

N91-25582*# Eastern Virginia Medical School,. Norfolk. Dept. of Pathology.

EFFECTS OF CLINOSTAT ROTATION ON AURELIA STATOLITH SYNTHESIS **c51**

Dorothy B. Spangenberg, S. Davis, and H. Ross-Clunis, III *In* NASA. Lyndon B. Johnson Space Center, Spacelab Life Sciences 1: Reprints of Background Life Sciences Publications May 1991 p 274-275 (For primary document see N91-25571 17-52)

(Grant NAG2-243)

Avail: NTIS HC/MF A18 CSCL 06C

Aurelia ephyrae develop eight graviceptors (rhopalia) during their metamorphosis from polyps, which are used for positional orientation with respect to gravity. In three experiments for each speed of 1/15, 1/8, 1/2, 1, and 24 rpm, groups of six polyps were rotated in the horizontal or vertical plane (control) using clinostats. Other controls were kept stationary in the two planes. Ten ephyrae from each group were collected after 5 to 6 days at 27 C in iodine and the number of statoliths per rhopalium were counted. Statistical analyses of statolith numbers revealed that horizontal clinostat rotation at 1/4 and 1/2 rpm caused the formation of significantly fewer statoliths per rhopalium than were found in controls. The finding that these slow rates of rotation reduces statolith numbers suggests that the developing ephyrae were disoriented with respect to gravity at these speeds, causing fewer statocytes to differentiate or to mineralize. Author

N91-25583*# Medicine and Dentistry Univ. of New Jersey, Camden. Dept. of Surgery.

METABOLISM OF NONESSENTIAL N15-LABELED AMINO ACIDS AND THE MEASUREMENT OF HUMAN WHOLE-BODY PROTEIN SYNTHESIS RATES

T. P. Stein, R. G. Settle, J. A. Albina, D. T. Dempsey, and G. Melnick (Pennsylvania Univ., Philadelphia.) *In* NASA. Lyndon B. Johnson Space Center, Spacelab Life Sciences 1: Reprints of Background Life Sciences Publications May 1991 p 276-284 (For primary document see N91-25571 17-52)

(Contract NAS9-16874; USPHS-AM-33431)

Avail: NTIS HC/MF A18 CSCL 06E

Eight N-15 labeled nonessential amino acids plus (15)NH4Cl were administered over a 10 h period to four healthy adult males using a primed-constant dosage regimen. The amount of N-15 excreted in the urine and the urinary ammonia, hippuric acid, and plasma alanine N-15 enrichments were measured. There was a high degree of consistency across subjects in the ordering of the nine compounds based on the fraction of N-15 excreted (Kendall coefficient of concordance W = 0.83, P is less than 0.01). Protein synthesis rates were calculated from the urinary ammonia plateau enrichment and the cumulative excretion of N-15. Glycine was one of the few amino acids that gave similar values by both methods. Author

N91-25584*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

A SYSTEMS APPROACH TO THE PHYSIOLOGY OF WEIGHTLESSNESS

Ronald J. White (Management and Technical Services Co., Houston, TX.), Joel I. Leonard, John A. Rummel, and Carolyn S. Leach *In its* Spacelab Life Sciences 1: Reprints of Background Life Sciences Publications May 1991 p 285-300 (For primary document see N91-25571 17-52)

Avail: NTIS HC/MF A18 CSCL 06E

A systems approach to the unraveling of the complex response pattern of the human subjected to weightlessness is presented. The major goal of this research is to obtain an understanding of the role that each of the major components of the human system plays following the transition to and from space. The cornerstone of this approach is the utilization of a variety of mathematical models in order to pose and test alternative hypotheses concerned with the adaptation process. An integrated hypothesis for the human physiological response to weightlessness is developed. Author

N91-25585*# Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.

PERCEPTION OF THE BODY IN SPACE: MECHANISMS

Laurence R. Young *In* NASA. Lyndon B. Johnson Space Center, Spacelab Life Sciences 1: Reprints of Background Life Sciences Publications May 1991 p 301-344 (For primary document see N91-25571 17-52)

Avail: NTIS HC/MF A18 CSCL 06E

The principal topic is the perception of body orientation and motion in space and the extent to which these perceptual abstraction can be related directly to the knowledge of sensory mechanisms, particularly for the vestibular apparatus. Spatial orientation is firmly based on the underlying sensory mechanisms and their central integration. For some of the simplest situations, like rotation about a vertical axis in darkness, the dynamic response of the semicircular canals furnishes almost enough information to explain the sensations of turning and stopping. For more complex conditions involving multiple sensory systems and possible conflicts among their messages, a mechanistic response requires significant speculative assumptions. The models that exist for multisensory spatial orientation are still largely of the non-rational parameter variety. They are capable of predicting relationships among input motions and output perceptions of motion, but they involve computational functions that do not now and perhaps never will have their counterpart in central nervous system machinery. The challenge continues to be in the iterative process of testing models by experiment, correcting them where necessary, and testing them again. B.G.

N91-25586*# Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.

GRAVITATIONAL EFFECTS ON BRAIN AND BEHAVIOR

Laurence R. Young *In* NASA. Lyndon B. Johnson Space Center, Spacelab Life Sciences 1: Reprints of Background Life Sciences Publications May 1991 p 345-353 (For primary document see N91-25571 17-52)
(Contract NAS9-15343)
Avail: NTIS HC/MF A18 CSCL 06E

Visual, vestibular, tactile, proprioceptive, and perhaps auditory clues are combined with knowledge of commanded voluntary movement to produce a single, usually consistent, perception of spatial orientation. The recent Spacelab flights have provided especially valuable observations on the effects of weightlessness and space flight. The response of the otolith organs to weightlessness and readapting to Earth's gravitation is described. Reference frames for orientation are briefly discussed. B.G.

N91-25587*# Massachusetts Inst. of Tech., Cambridge. Man-Vehicle Lab.
MIT/CANADIAN VESTIBULAR EXPERIMENTS ON THE SPACELAB-1 MISSION. PART 1: SENSORY ADAPTATION TO WEIGHTLESSNESS AND READAPTATION TO ONE-G: AN OVERVIEW
Laurence R. Young, C. M. Oman, D. G. D. Watt, K. E. Money (Defence and Civil Inst. of Environmental Medicine, Downsview, Ontario), B. K. Lichtenberg, R. V. Kenyon, and A. P. Arrott *In* NASA. Lyndon B. Johnson Space Center, Spacelab Life Sciences 1: Reprints of Background Life Sciences Publications May 1991 p 346-353 (For primary document see N91-25571 17-52)
Avail: NTIS HC/MF A18 CSCL 06E

Experiments on human spatial orientation were conducted on four crewmembers of Space Shuttle Spacelab Mission 1. The conceptual background of the project, the relationship among the experiments, and their relevance to a 'sensory reinterpretation hypothesis' are presented. Detailed experiment procedures and results are presented in the accompanying papers in this series. The overall findings are discussed as they pertain to the following aspects of hypothesized sensory reinterpretation in weightlessness: (1) utricular otolith afferent signals are reinterpreted as indicating head translation rather than tilt, (2) sensitivity of reflex responses to footward acceleration is reduced, and (3) increased weighting is given to visual and tactile cues in orientation perception and posture control. Results suggest increased weighting of visual cues and reduced weighting of graviceptor signals in weightlessness.
Author

N91-25588# National Inst. for Occupational Safety and Health, Morgantown, WV. Div. of Safety Research.
PERFORMING MOTOR AND SENSORY NEURONAL CONDUCTION STUDIES IN ADULT HUMANS
D. E. Nestor and R. M. Nelson Sep. 1990 74 p
(PB91-152736; DHHS/PUB/NIOSH-90-113) Avail: NTIS HC/MF A04 CSCL 06P

Guidelines were provided for the performance of routine nerve conduction studies of selected peripheral nerves in adult humans. The manual was the result of three working group meetings. Participants in the working groups included neurophysiologists, therapists, physicians, and allied health professionals recognized for their expertise in electrophysiologic assessment of neuromuscular disorders. The guidelines were meant to serve as a starting point for electrophysiologic assessment procedures for evaluating common motor and sensory neuronal conduction disorders encountered in the workplace. The procedures were intended to be used to objectively assess the motor and sensory neuronal conduction status of adult workers subjected to cumulative trauma, toxic substances, or other factors that could cause acute or chronic neuromuscular disorders. Assessment of unusual and unique problems may require sound, creative modification of the standard procedures. GRA

N91-25589*# Texas A&M Univ., College Station. Dept. of Industrial Engineering.
CHARACTERIZATION OF SLOW AND FAST PHASE NYSTAGMUS Final Technical Report, 1 Jan. 1990 - 28 Jun. 1991
Charles S. Lessard, Carlos A. Rodriguez-Garcia, Wing Chan Wong, Jae J. Im, and Glenn F. Schmidt 28 Jun. 1991 191 p
(Grant NAG9-303)
(NASA-CR-188452; NAS 1.26:188452) Avail: NTIS HC/MF A09 CSCL 06P

A current literature review of the analog and digital process of vestibular and optical kinetic nystagmus reveals little agreement in the methods used by various labs. The strategies for detection of saccade (fast phase velocity component of nystagmus) vary between labs, and most of the process have not been evaluated and validated with a standard database. A survey was made of major vestibular labs in the U.S. that perform computer analyses of vestibular and optokinetic reflexes to stimuli, and a baseline was established from which to standardize data acquisition and analysis programs. The concept of an Error Index was employed as the criterium for evaluating the performance of the vestibular analysis software programs. The performance criterium is based on the detection of saccades and is the average of the percentages of missed detections and false detections. Evaluation of the programs produced results for lateral gaze with saccadic amplitude of one, two, three, five, and ten degrees with various signal-to-noise ratios. In addition, results were obtained for sinusoidal pursuit of 0.05, 0.10, and 0.50 Hz with saccades from one to ten degrees at various signal-to-noise ratios. Selection of the best program was made from the performance in the lateral gaze with three degrees of saccadic amplitude and in the 0.10 Hz sinusoid with three degrees of saccadic amplitude. Author

N91-25590 Maryland Univ., College Park.
PREDICTION OF MUSCULAR SYNERGISM AND ANTAGONISM OF HUMAN UPPER EXTREMITY: A DYNAMIC OPTIMIZATION APPROACH Ph.D. Thesis
Yohanan Giat 1990 358 p
Avail: Univ. Microfilms Order No. DA9110298

A simulation of the skeletal and muscular dynamics of the upper extremity was conducted in an attempt to compute the activity which occurs in each muscle when a comfortable movement is performed. The right upper extremity was modeled as a two-bar linkage moving in the vertical plane of the scapula. The musculo-tendon actuation system was modeled in terms of twelve muscles moving in three-dimensional space. Each muscle was governed by two ordinary differential equations: one for its mechanism and another for its activation. The analysis revealed forty ordinary differential equations governing the dynamics of the upper extremity. Specific muscle parameters were obtained by performing a cadaver dissection; specific skeleton parameters were taken from three-dimensional anthropometric measurements. These parameters were then scaled to fit each subject. The muscle activity was then computed utilizing a bang-bang optimal control procedure, while the muscular stress, joint constraint forces and neural excitation were minimized. The results obtained from the simulation program describe all the dynamic events that take place in the upper extremity when the investigated movement is attempted. The computed results reveal that the upper extremity performed the expected motion in a way somewhat similar to that which had been recorded experimentally. The computed muscle tension histories describe the synergistic and antagonistic activities that occur in the upper extremity when the simulated movement takes place. Recommendations are made to include in the model the effect of the bony and ligamentous support; to modify the cost function and the activation model so that a nonlinear, as opposed to a bang-bang, optimal control algorithm is used; and to economize the overall computation, particularly that of the costate vector. Dissert. Abstr.

N91-25591# Joint Publications Research Service, Arlington, VA.
JPRS REPORT: SCIENCE AND TECHNOLOGY. USSR: LIFE SCIENCES
29 Mar. 1991 65 p Transl. into ENGLISH from various Russian articles
(JPRS-ULS-91-008) Avail: NTIS HC/MF A04

Abstracts of Soviet literature in various areas of the life sciences are compiled. The following subject areas are covered:

biochemistry, biophysics, biotechnology, epidemiology, immunology, laser bioeffects, medicine, microbiology, molecular biology, public health, and radiobiology. For individual titles, see N91-25592 through N91-25592.

N91-25592# Joint Publications Research Service, Arlington, VA.
FEATURES OF OPTOKINETIC, OPTOOCULOMOTOR AND VESTIBULOOCULOMOTOR RESPONSES IN WEIGHTLESSNESS
L. N. Kornilova and G. Bodo *In its* JPRS Report: Science and Technology. USSR: Life Sciences 29 Mar. 1991 p 1-5 Transl. into ENGLISH from Vestnik Otorinolaringologii (Moscow, USSR), no. 3, May - Jun. 1990 p 37-43 (For primary document see N91-25591 17-52)
Avail: NTIS HC/MF A04

The results are presented of a study of optooculomotor and vestibulooculomotor responses in weightlessness during the Optokinez experiment, which was carried out in 1984 during the seven-day mission of Soviet-Indian crew and during the 237-day mission aboard the Salyut-7 station. The objectives of the experiment were to study spontaneous oculomotor activity and the effect of optokinetic stimulation (OKS) on it; assess fixational rotation and tracking movements of the eyes; determine threshold and above-threshold sensitivity of oculomotor function to graded OKS in different directions; assess vestibulooculomotor responses to primarily otolithic stimulation (rocking the head in the frontal plane) and ampullar stimulation (rocking the head about the longitudinal axis); assess the effect of active head movements on optooculomotor responses; and investigate adaptation of sensory systems to weightlessness from oculomotor responses to vestibular simulation and OKS. Author

N91-25593# Oak Ridge National Lab., TN.
RADIATION SHIELDING REQUIREMENTS FOR MANNED DEEP SPACE MISSIONS
R. T. Santoro and D. T. Ingersoll Apr. 1991 25 p
(Contract DE-AC05-84OR-21400)
(DE91-010723; ORNL/TM-11808) Avail: NTIS HC/MF A03

Galactic cosmic rays (GCR) and, particularly, solar flares (SF) constitute the major radiation hazards in deep space. The dose to astronauts from these radiation sources and the shielding required to mitigate its effect during a 480 day Mars mission is estimated for a simplistic spacecraft geometry. The intent is to ball park the magnitude of the doses for the constant GCR background and for SF's that occur randomly during the mission. The spacecraft shielding and dose data are given only for primary GCR and SF radiation, recognizing that secondary particles produced by primary particle reactions in the spacecraft and High Z-High Energy particles will also contribute to the dose suffered by the astronauts. DOE

N91-25594# Oak Ridge National Lab., TN.
RADIO FREQUENCY BIOLOGICAL HAZARDS AND MEASUREMENT TECHNIQUES
M. R. Moore 1991 7 p Presented at the 1991 European Muon Collaboration (EMC) Expo, Orlando, 25-27 Jun. 1991
(Contract DE-AC05-84OR-21400)
(DE91-010776; CONF-9106168-1) Avail: NTIS HC/MF A02

An introduction is given that includes natural radio frequency (RF) sources, natural energy produced by the body, and how these compare to domestic exposure standards. Thermal and athermal biological effects of RF fields including known effects and others still under investigation are discussed. Applicable domestic and foreign exposure standards are compared. Also, specific examples are given of public concerns that have arisen. Various instrumentation for quantifying the electromagnetic field levels is described, as well as the manner in which these instruments can be used to survey the field levels present in a given area. DOE

N91-25595# Lawrence Livermore National Lab., CA.
HEALTH RISKS FROM EXPOSURE TO TRITIUM
T. Straume 22 Feb. 1991 68 p
(Contract W-7405-eng-48)
(DE91-011008; UCRL-LR-105088) Avail: NTIS HC/MF A04

Estimates of the health risks in humans from low level exposure to tritiated water (sup 3)HOH or organically bound tritium (OBT) are presented. The health risks considered are those for cancer, genetic effects, developmental effects, and reproductive effects. Because direct risk information for these effects is not available from human exposures to tritium, a three step approach was used. First, excess risks for the above effects following low level exposure to x rays or gamma rays were estimated from available human epidemiological data, using appropriate dose-rate effectiveness factors (DREFs). Second, through detailed review of the tritium relative biological effectiveness (RBE) data from laboratory studies, best-estimate RBEs for these classes of effects were obtained for tritium. Finally, the human risk estimates for low-level x rays or gamma rays were multiplied by the appropriate best estimate RBEs for tritium, taking into account differences in effectiveness of comparison radiations. The resultant lifetime risk coefficients for low level exposure to (sup 3)HOH are presented. The risks from exposure to OBT molecules are estimated to range from values that are similar to those for (sup 3)HOH to about à factor of two higher. DOE

N91-25596# Argonne National Lab., IL.
PROTECTION AGAINST UVA-INDUCED PHOTOOXIDATIVE DAMAGE IN MAMMALIAN CELL LINES EXPRESSING INCREASED LEVELS OF METALLOTHIONEIN
E. J. Dudek, J. G. Peak, M. J. Peak, and R. M. Roth (Illinois Inst. of Tech., Chicago.) 1990 7 p Presented at the 5th Biennial Meeting on Oxidative Damage and Repair, Pasadena, 14-20 Nov. 1990
(Contract W-31-109-eng-38)
(DE91-010791; ANL/CP-70911; CONF-9011196-1) Avail: NTIS HC/MF A02

Metallothionein (MT) is an endogenous low molecular weight protein that is inducible in a variety of eukaryotic cells and has the ability to selectivity bind heavy metal ions such as zinc and the cadmium. Although the exact physiological role of MT is still not understood, there is strong evidence that MT is involved in providing cellular resistance against the damaging effects of heavy metals and in the regulation of intracellular zinc and copper. Recently, it has been demonstrated that MT can scavenge radiation-induced reactive oxygen intermediates in vitro, specifically hydroxyl and superoxide radicals, and because of these observations it has been suggested that MT may provide protection against radiation-induced oxidative stress in vivo. Cell lines expressing increased levels of MT have demonstrated resistance to ionizing radiation, to ultraviolet radiation, and also to various DNA damaging agents including melphalan and cis-diamine-dichloroplatinum. It is therefore important to gain some insight into the relationship between cellular MT content and cellular resistance to radiation and other DNA damaging agents. In this study we investigated the role of MT in providing protection against monochromatic 365-nm UVA radiation, which is known to generate intracellular reactive oxygen species that are involved in both DNA damage and cell killing. For this purpose, we used zinc acetate, a potent inducer of MT, to elevate MT levels in V79 Chinese hamster fibroblasts prior to UVA exposure and determined cell survival for uninduced and induced cultures. In order to eliminate any zinc effects other than MT induction, we also isolated and characterized cadmium chloride-resistant clones of V79 cells that have increased steady-state levels of both MT mRNA and protein, and we examined their survival characteristics against 365-nm radiation in the absence of zinc acetate. DOE

N91-25597# Columbia Univ., New York, NY.
LOW DOSE NEUTRON LATE EFFECTS: CATARACTOGENESIS
B. V. Worgul Apr. 1991 5 p
(Contract DE-FG02-90ER-61009)
(DE91-011020; DOE/ER-61009/1) Avail: NTIS HC/MF A01

The work is formulated to resolve the uncertainty regarding the relative biological effectiveness. The endpoint which is being utilized is cataractogenesis. The advantages conferred by this

system stems primarily from the non-invasive longitudinal analysis which it allows. It also exploits a well defined system and one which has demonstrated sensitivity to the inverse dose rate effect observed with heavy ions. Four week old rats were divided into 8 dose groups which received single or fractionated total doses of 0.2, 1.0, 5.0, and 25 cGy of monoenergetic 435 keV neutrons. Special restraining jigs were devised to insure that the eye at the midpoint of the lens received the appropriate energy and dose with a relative error of + or - 5 percent. The fractionated regimen consisted of four exposures, each administered at 3 hour intervals. The reference radiations, 250 kVp x rays, were administered in the same fashion but in doses ranging from .5 to 6.0 Gy. The animals are examined on a bi-weekly basis utilizing conventional slit-lamp biomicroscopy and the Scheimpflug Slit-lamp Imaging System. The follow-ups will continue throughout the lifespan of the animals. When opacification begins full documentation will involve the Zeiss imaging system and Oxford retroillumination photography. The processing routinely employs the Merriam/Focht scoring system for cross-referencing with previous cataract studies and establish cataractogenecity using a proven scoring method. DOE

N91-25598# Boston Univ., MA. Dept. of Chemistry.
SCINTILLATION MATERIALS FOR MEDICAL APPLICATIONS
A. Lempicki, A. J. Wojtowicz, and E. Berman 1991 28 p
(Contract DE-FG02-90ER-61033)
(DE91-011022; DOE/ER-61033/1) Avail: NTIS HC/MF A03

This report covers the first seven months of the first year of work under the above Grant. As such, it is rather preliminary. The concrete steps taken to implement the program are described. In Section 2 the progress towards the development of the instrumentation and facilities needed to conduct the work and the materials which have been acquired, is described. In Section 3 an account is given on preliminary measurements which have already been made as well as some calculations aimed at interpreting experimental results. Additionally the general way of thinking about the problem of improving scintillator materials is expanded. This subject is covered in the Appendix Scintillator Research, which is an evolving document, not to be regarded as finished. In fact the last section cannot be finished in time for this report. We believe it serves the dual purpose of articulating the research goals and priorities for the purposes and at the same time to communicating them to the sponsor. DOE

N91-25599# Los Alamos National Lab., NM.
RADIATION EXPOSURE AND PROTECTION FOR MOON AND MARS MISSIONS
R. E. MacFarlane, R. E. Prael, D. D. Strottman, G. F. Strniste, and W. C. Feldman Apr. 1991 18 p
(Contract W-7405-eng-36)
(DE91-011346; LA-11904-MS) Avail: NTIS HC/MF A03

A deep space radiation environment of galactic cosmic rays and energetic particles from solar flares imposes stringent requirements for radiation shielding for both personnel and electronic equipment at a moon base or on a Mars expedition. Current Los Alamos capabilities for calculating the effect of such shielding are described, and extensions and validation needed before actual manned deep space missions are launched are outlined. The biological effects of exposure to cosmic-ray ions and to low doses of radiation at low dose rates are poorly understood. Recent Los Alamos work on mutation effects in cells, DNA repair processes, and the analysis of chromosomal aberrations promises to increase our understanding of the basic processes, to provide methods to screen for radiation sensitivity, and to provide advanced dosimetry equipment for space missions. DOE

N91-25600* National Aeronautics and Space Administration, Washington, DC.
AEROSPACE MEDICINE AND BIOLOGY: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 350)
Jun. 1991 56 p
(NASA-SP-7011(350); NAS 1.21:7011(350)) Avail: NTIS HC A03; NTIS standing order as PB91-912300, $15.00 domestic, $30.00 foreign CSCL 06E

This bibliography lists 152 reports, articles and other documents introduced into the NASA Scientific and Technical Information System during May 1991. Subject coverage includes: aerospace medicine and psychology, life support systems and controlled environments, safety equipment, exobiology and extraterrestrial life, and flight crew behavior and performance. Author

N91-25603# Hamburg Univ. (Germany, F.R.). Dept. of Eyes.
LASER EFFECTS UPON THE STRUCTURE AND FUNCTION OF THE EYE AS A FUNCTION OF DIFFERENT WAVELENGTHS
J. Draeger, R. Schwartz, and C. Stern *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 4 p (For primary document see N91-25602 17-54)
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N91-25604# Army Aeromedical Research Lab., Fort Rucker, AL. Visual Sciences Branch.
ULTRAVIOLET RADIATION EFFECTS ON THE CORNEAL EPITHELIUM
Morris R. Lattimore, Jr. *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 5 p (For primary document see N91-25602 17-54)
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N91-25605# Institute of Aviation Medicine, Fuerstenfeldbruck (Germany, F.R.).
EYE DAMAGE INDUCED BY SOLAR RADIATION
H. Brandl and F.-J. Daumann *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 5 p (For primary document see N91-25602 17-54)
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N91-25608# Institute for Perception RVO-TNO, Soesterberg (Netherlands).
A TWO CLASS MODEL FOR PHOTOCHEMICAL DAMAGE OF THE RETINA
D. vanNorren *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 4 p (For primary document see N91-25602 17-54)
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N91-25610# Office of the Air Force Surgeon General, Washington, DC.
USE OF CONTACT LENSES (CL) BY AIRCREW IN THE USAF Progress Report
Thomas M. McNish *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 4 p (For primary document see N91-25602 17-54)
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N91-25611# Army Aeromedical Research Lab., Fort Rucker, AL. Visual Sciences Branch.
CONTACT LENSES IN THE US ARMY ATTACK HELICOPTER ENVIRONMENT
Morris R. Lattimore, Jr. *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 3 p (For primary document see N91-25602 17-54)
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N91-25612# Royal Air Force, London (England).
TEN YEARS FLYING WITH SOFT CONTACT LENSES
J. K. Cloherty *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 12 p (For primary document see N91-25602 17-54)

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N91-25613# Rigshospitalet, Copenhagen (Denmark). Dept. of Aviation Medicine.
SOFT CONTACT LENS WEAR AND AVIATION
Steen Tinning and Jannik Boberg-Ans *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 3 p (For primary document see N91-25602 17-54)
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N91-25614# Aerospace Medical Research Labs., Wright-Patterson AFB, OH. Crew Systems Effectiveness Branch.
EFFECT OF AIRCRAFT CABIN ALTITUDE AND HUMIDITY ON OXYGEN TENSION UNDER SOFT AND HARD GAS-PERMEABLE CONTACT LENSES
Melvin R. ONeal *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 9 p (For primary document see N91-25602 17-54)
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N91-25615# Institute of Aviation Medicine, Fuerstenfeldbruck (Germany, F.R.).
INTRA-OCULAR LENSES AND MILITARY FLYING QUALIFICATIONS
F.-J. Daumann and H. Brandl *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 4 p (For primary document see N91-25602 17-54)
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N91-25616# School of Aerospace Medicine, Brooks AFB, TX. Ophthalmology Branch.
CATARACT SURGERY AND INTRAOCULAR LENSES IN USAF AVIATORS
Debra L. Moorman and Robert P. Green *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 6 p (For primary document see N91-25602 17-54)
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N91-25617# Rigshospitalet, Copenhagen (Denmark). Dept. of Aviation Medicine.
CONTRAST SENSITIVITY AND GLARE FOLLOWING KERATOTOMY
Steen Tinning *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 3 p (For primary document see N91-25602 17-54)
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N91-25618# Institute of Ophthalmology, London (England). Dept. of Clinical Ophthalmology.
A SURVEY OF COLOUR DISCRIMINATION IN GERMAN OPHTHALMOLOGISTS: CHANGES ASSOCIATED WITH THE USE OF LASERS AND OPERATING MICROSCOPES
G. B. Arden, T. Berninger, C. R. Hogg, and E. Lund (Munich Eye Hospital, Germany, F.R.) *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 6 p Sponsored in part by Wellcome Trust and Wolfson Foundation (For primary document see N91-25602 17-54)
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N91-25619# School of Aerospace Medicine, Brooks AFB, TX. Human Systems Div.
MEDICAL MANAGEMENT OF COMBAT LASER EYE INJURIES
Robert P. Green, Jr., Robert M. Cartledge, Frank E. Cheney, and Arthur R. Menendez *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 7 p (For primary document see N91-25602 17-54)
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53 BEHAVIORAL SCIENCES

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

N91-25601*# Bio-Dynamics Research and Development Corp., Eugene, OR.
USER ACCEPTANCE OF INTELLIGENT AVIONICS: A STUDY OF AUTOMATIC-AIDED TARGET RECOGNITION
Curtis A. Becker, Brian C. Hayes, and Patrick C. Gorman May 1991 19 p Prepared in cooperation with Army Aviation Systems Command, Moffett Field, CA
(Contract NAS2-12849)
(NASA-CR-177583; A-91095; NAS 1.26:177583;
AVSCOM-TR-90-A-009) Avail: NTIS HC/MF A03 CSCL 05I
User acceptance of new support systems typically was evaluated after the systems were specified, designed, and built. The current study attempts to assess user acceptance of an Automatic-Aided Target Recognition (ATR) system using an emulation of such a proposed system. The detection accuracy and false alarm level of the ATR system were varied systematically, and subjects rated the tactical value of systems exhibiting different performance levels. Both detection accuracy and false alarm level affected the subjects' ratings. The data from two experiments suggest a cut-off point in ATR performance below which the subjects saw little tactical value in the system. An ATR system seems to have obvious tactical value only if it functions at a correct detection rate of 0.7 or better with a false alarm level of 0.167 false alarms per square degree or fewer. Author

N91-25130# Air Force Systems Command, Kirtland AFB, NM. Directorate of Aerospace Studies.
KNOWLEDGE EXTRACTION METHODS FOR THE DEVELOPMENT OF EXPERT SYSTEMS
Manuel Perez, Leopoldo Gemoets, and Robert G. McIntyre (Texas Univ., El Paso.) *In* AGARD, Knowledge Based System Applications for Guidance and Control Apr. 1991 10 p (For primary document see N91-25121 17-04)
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54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

Includes human engineering; biotechnology; and space suits and protective clothing.
For related information see also *16 Space Transportation.*

N91-25602# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Aerospace Medical Panel.
OCULAR HAZARDS IN FLIGHT AND REMEDIAL MEASURES
May 1991 121 p In ENGLISH and FRENCH Symposium held in London, England, 22-26 Oct. 1990
(AGARD-CP-492; ISBN-92-835-0616-2) Copyright Avail: NTIS HC/MF A06; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive
The operational use of contact lenses by military aircrew, cataract surgery and intra-ocular lenses, the correction of refractive errors by radial keratotomy, impairment of color vision in ophthalmologists using argon lasers, and the medical management of combat laser eye injuries are examined. For individual titles, see N91-25603 through N91-25619.

N91-25603# Hamburg Univ. (Germany, F.R.). Dept. of Eyes.
LASER EFFECTS UPON THE STRUCTURE AND FUNCTION OF THE EYE AS A FUNCTION OF DIFFERENT WAVELENGTHS **c52**
J. Draeger, R. Schwartz, and C. Stern *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 4 p (For primary document see N91-25602 17-54)
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A laser produces a narrow beam of monochromatic, coherent light in the visible, infrared, or ultraviolet parts of the spectrum. The power in a continuous beam can range from a fraction of a milliwatt to more than a megawatt. The applications and range of laser devices is broad. Helium-neon, argon, carbon dioxide, excimer, neodymium, and YAG lasers are described. The attendant hazards of laser operations vary greatly depending upon the exact type of laser and its application. The effects of optical radiation on the eye vary significantly with wavelength. Injuries to the anterior and posterior part of the eye are described. Prevention of laser-induced injuries are briefly discussed. Author

N91-25604# Army Aeromedical Research Lab., Fort Rucker, AL. Visual Sciences Branch.
ULTRAVIOLET RADIATION EFFECTS ON THE CORNEAL EPITHELIUM **c52**
Morris R. Lattimore, Jr. *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 5 p (For primary document see N91-25602 17-54)
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Since military troops are involved in extensive outdoor activities with chronic exposure to solar radiation, and since ultraviolet radiation (UVR) lasers may play a role in the future military environment, a thorough understanding of UVR damage mechanisms is crucial to the development of intervention and treatment modalities. The present research was directed at quantifying possible alterations in corneal epithelial metabolic activity secondary to in-vivo exposure to UVR in the rabbit. Author

N91-25605# Institute of Aviation Medicine, Fuerstenfeldbruck (Germany, F.R.).
EYE DAMAGE INDUCED BY SOLAR RADIATION **c52**
H. Brandl and F.-J. Daumann *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 5 p (For primary document see N91-25602 17-54)
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With the current methods including color vision tests with the Hue-test 100 no eye damages in the blue-light spectrum of solar radiation could so far be verified in flight filtering effect and a complete blocking in the UV-spectrum most likely provide adequate protection. The previous experience, however, should not keep one from striving for refinement of examination methods especially in the blue-light spectrum in order not to overlook insidious damage. The point is to avoid phototoxic damage. It is the task to provide safety for the pilot; this can be achieved by an advancement of knowledge, measuring methods, and consequent actions. Author

N91-25606# Institute of Aviation Medicine, Farnborough (England).
AIRCREW SUNGLASSES
D. H. Brennan *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 6 p (For primary document see N91-25602 17-54)
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The hazards of light are now better understood and it is imperative that aircrew, who may fly in ambient illuminance levels reaching 150,000 lux or greater, be provided with adequate protection. The primary hazards are from the CIE (International Commission on Illumination) photobiological bands starting at the ultra violet-B and extend through to the infrared-A although the latter is relatively unimportant. Potentially the most serious hazard is from the visible band below 500 nm; these highly energetic photons constitute the blue light hazard to the retina. The spectral transmittance of a sunfilter must take into account these hazards while at the same time not adversely affecting color discrimination. A good sunfilter should not only protect the eyes but also improve visual acuity and contrast discrimination both in haze and glare conditions. Author

N91-25607# Army Medical Research and Development Command, Fort Detrick, MD.
LASER PROTECTION WITH IMAGE INTENSIFIER NIGHT VISION DEVICES
David J. Walsh *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 7 p (For primary document see N91-25602 17-54)
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Current military ranging and targeting technology employs high power laser systems which can seriously damage the retina of the eye. Based on eye anatomy and function, three critical central retinal regions which must be protected - fovea, macula, and peripapillary zone (1 to 2 degree annulus surrounding the optic disc) - are included in a circular area with a 25-degree radius. In the aviation community, barrier-type laser protection inherent with night vision devices (NVDs) was thought to be adequate. The NVD barrier protection exceeds the recommended 25 degree minimum only when the eyes are in the primary (straight ahead) position. With normal scanning eye movement, critical areas of the retina become exposed to laser damage. Continuous laser protection for the central retina will require either a mechanical obstruction or a laser protective spectacle or visor which covers at least 90 degrees. The mechanical laser protection provided by NVD wear alone is not adequate to protect the aviator. Author

N91-25608# Institute for Perception RVO-TNO, Soesterberg (Netherlands).
A TWO CLASS MODEL FOR PHOTOCHEMICAL DAMAGE OF THE RETINA **c52**
D. vanNorren *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 4 p (For primary document see N91-25602 17-54)
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A basic understanding of the mechanisms involved in photochemical damage to the eye is needed. The focus is on retinal light hazards mediated by photochemical processes, and related to exposures lasting from a few seconds to one or two days. It is proposed that from a simple model with two retinal photosensitizers, the shape of the threshold curve for light damage can be predicted. Because the action spectrum for light damage is also known from this model, the damage threshold can be calculated for an arbitrary light source. Author

N91-25609# British Aerospace Public Ltd. Co., Bristol (England). Human Factors Dept.
THE EFFECTS OF DAZZLE AND DAZZLE GENERATED AFTERIMAGES ON AIMING AND TRACKING PERFORMANCE
A. Kelvin Davies *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 8 p Sponsored in part by Ministry of Defence, England (For primary document see N91-25602 17-54)
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A series of experiments was designed to collect data for the modeling of aiming and tracking performance during and after dazzle exposure. Compensatory tracking performance was measured for static targets and targets moving with a constant linear velocity using a laboratory based tracking simulator. Tracking error was recorded with a bright noncoherent dazzle source overlaid on the target and with target-dazzle separations of 0.5, 1.0, 2.0, and 3.0 degrees. There was an indication that the dazzle source caused a significant deterioration in tracking performance. Tracking

errors were inversely related to the separation between target and dazzle source and were at a maximum when target and dazzle were coincident. The effects of dazzle may persist for a significant time after dazzle offset. Foveal afterimages measuring 1 degree were generated by brief exposure to an intense light source. Tracking error with an afterimage was recorded and compared to the errors recorded for normal foveal vision, and those arizing when tracking using regions of the retina 2, 4, and 6 degree peripheral to the fovea. A significant deterioration in tracking performance was evident with an afterimage. Comparable results were obtained when tracking using the peripheral retina at 4 to 6 degrees. This similarity is attributed to observers offsetting their gaze so as to image the target away from the non-functioning foveal receptors. A significant learning effect was indicated.

Author

N91-25610# Office of the Air Force Surgeon General, Washington, DC.

USE OF CONTACT LENSES (CL) BY AIRCREW IN THE USAF Progress Report **c52**

Thomas M. McNish *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 4 p (For primary document see N91-25602 17-54)

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In Jun. 1989, the Chief of Staff, USAF approved a plan authorizing, for the first time, the use of corrective CL (contact lenses) in flight by aircrews of the USAF. Eligible aircrew under this plan include all those requiring distant vision correction and having less than 2 diopters astigmatism. There is a recognized operational advantage to the use of CL vice spectacles in several air force missions. These include, most notably, the operation of high performance aircraft, and/or the use of night vision goggles to accomplish the mission. Therefore, the use of CL in flight is now optional for all physically qualified aircrew in the USAF. Prior to initiation of this program, a thorough literature search was accomplished. Based on data from studies on the complications associated with CL, the loss of 70 flying days per 1000 CL wearing aviators and four permanent groundings per 10000 CL-wearing aviators per year were predicted from CL-related problems. Safety of flight in high performance aircraft with CL was determined by a 1-year study of 89 aviators in Tactical Air Command, completed in 1989. Complication rates were very close to those predicted. In order to further validate predictions, or rapidly detect any any negative trends, the implementation plan includes a requirement for close professional followup of all CL-wearing aviators. Detailed quarterly reports on total number of CL-wearing aircrew, CL-related medical groundings, safety incidents, etc., are required by the Surgeon General, USAF. So far, there have been no permanent groundings nor CL-related safety incidents. After 856 aircrew-years of CL use, the rate of temporary grounding remains close to early predictions.

Author

N91-25611# Army Aeromedical Research Lab., Fort Rucker, AL. Visual Sciences Branch.

CONTACT LENSES IN THE US ARMY ATTACK HELICOPTER ENVIRONMENT **c52**

Morris R. Lattimore, Jr. *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 3 p (For primary document see N91-25602 17-54)

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Recent technological advances have had a major impact on military aviation. While modern methods of providing visual information via electro-optics/visionics systems have extended the aviator's operational envelope, these devices are becoming increasingly incompatible with spectacle wear. Since approximately 20 percent of Army aviators are ametropic (spectacle wearing), alternative means of providing a refractive error correction need to be investigated. One alternative being considered is the use of a contact lense correction. For the past year, the U.S. Army Aeromedical Research Laboratory (USAAEL) has been conducting a worldwide, AH-64 Apache contact lense research project in order to develop a comprehensive database on contact lens wear in a variety of environments. A three-tier contact lens fitting system is being used: two different types of soft lenses and one rigid gas permeable (RGP) lens type. The wearing schedule is set at a maximum of 7 days/6 nights of extended lens wear. Fundamental operational data is being chronicled by unit flight surgeons. Standard clinical data is being used in on-going command deliberations on future medical policy decisions concerning contact lens wear by Army aviators. Basic research information is being gathered in an effort to determine the fundamental physiological response to the cornea to the presence of a contact lens. Up-to-date results are presented as an introduction to interactive discussions. The subjective assessment of contact lens applications within the aviation community is universal acceptance. While current clinical data indicate some ocular health risk, flight safety risks are minimal. Establishment of long-term contact lens efficiency likely will depend on the ensuing analysis of physiological data.

Author

N91-25612# Royal Air Force, London (England).

TEN YEARS FLYING WITH SOFT CONTACT LENSES **c52**

J. K. Cloherty *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 12 p (For primary document see N91-25602 17-54)

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In 1980 the RAF started an Aircrew Soft Contact Lenses (ASCL) Trial, Phase 1, to assess the value and safety of soft contact lenses for those aircrew who wear corrected flying spectacles (CFS). For this trial two soft contact lenses were selected. The high water content Scanlens 75 and the Medium water content Snoflex 50. The volunteers were selected from aircrew and medical officers. The subjects were measure (pre-fitting and post-fitting) and exposed to adverse environmental conditions likely to be encountered in flight. In all instances, the visual performance wearing soft contact lenses did not differ significantly from their performance when wearing CFS. In 1981 the Snoflex 50 lenses were abandoned because they were unsuitable for extended wear. In 1985 the care regime of the Scanlens 75 was changed to the SEPTICON care system. It was concluded that soft contact lenses are a viable and worthwhile alternative to CFS for aircrew. B.G.

N91-25613# Rigshospitalet, Copenhagen (Denmark). Dept. of Aviation Medicine.

SOFT CONTACT LENS WEAR AND AVIATION **c52**

Steen Tinning and Jannik Boberg-Ans *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 3 p (For primary document see N91-25602 17-54)

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Soft contact lenses were proposed as an alternative to spectacles, when refractive errors are corrected in high performance fighter pilots. In the present study the effect on visual acuity was examined, when soft contact lenses were used during altitude simulated flying within a low pressure chamber. It can be concluded, that neither visual acuity nor visual comfort are effected by the use of soft contact lenses. Based on the experience from one pilot, soft contact lenses seems to be superior to spectacles when refractive errors has to be corrected in high performance fighter pilots.

Author

N91-25614# Aerospace Medical Research Labs., Wright-Patterson AFB, OH. Crew Systems Effectiveness Branch.

EFFECT OF AIRCRAFT CABIN ALTITUDE AND HUMIDITY ON OXYGEN TENSION UNDER SOFT AND HARD GAS-PERMEABLE CONTACT LENSES **c52**

Melvin R. ONeal *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 9 p (For primary document see N91-25602 17-54)

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The primary source of oxygen to the cornea is from the ambient air. Contact lenses decrease the oxygen getting to the corneal

surface; and below a critical oxygen level corneal hypoxia occurs and the cornea swells. Repeated corneal edema may be implicated in the adverse effects of extended contact lens wear. The military flying environment includes aircraft cabin pressure that is decreased from normal sea level and cabin humidity that is usually much lower than normal. A calculational approach was used to access the effect of various cabin environments on oxygen levels under both soft and hard gas-permeable (HGP) contact lenses. The oxygen tension under 55 percent and 71 percent H2O soft lenses during normal wear and at 18 percent relative humidity and under HGP lenses of various oxygen transmissibility was calculated for 8000 and 16000 ft cabin altitudes. Both altitude and dehydration affect the oxygen under soft lenses, while hard lenses do not dehydrate and have the benefit of added oxygen with tear exchange during blinking. The calculated oxygen tension under the hard lens is 2 to 3 times that under soft lenses at all cabin altitudes. In normal soft lens extended wear the cornea deswells the following day; however, during flight, the lower oxygen under soft lenses could affect corneal recovery in aircrew. The cabin environment is shown to result in calculated oxygen levels under contact lenses that are substantially reduced from normal, and needs consideration. Author

N91-25615# Institute of Aviation Medicine, Fuerstenfeldbruck (Germany, F.R.).

INTRA-OCULAR LENSES AND MILITARY FLYING QUALIFICATIONS **c52**

F.-J. Daumann and H. Brandl *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 4 p (For primary document see N91-25602 17-54)

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The development of intra-ocular lenses (IOLs) to the present day routine implantation was accompanied by mixed emotions. In order to understand this reception, a brief history of cataract surgery is discussed. In 1975 IOL's were implanted at a more favorable site. Lens design and materials were considerably improved, the surfaces polished, sterilization and instruments improved. Now an assessment of the qualifications for military flying duty was made by examining aircrew and their performance (with IOLs). It was decided that in assessing whether flight crews should be granted wavers after cataract surgery with IOLs, that the surgery as such cannot meet the requirement. Each case must be evaluated separately. The following criteria must be met: visual acuity must be 1.0; no measurable disturbance through glare; intra-ocular eye pressure must be normal; and no inflamatory process. B.G.

N91-25616# School of Aerospace Medicine, Brooks AFB, TX. Ophthalmology Branch.

CATARACT SURGERY AND INTRAOCULAR LENSES IN USAF AVIATORS **c52**

Debra L. Moorman and Robert P. Green *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 6 p (For primary document see N91-25602 17-54)

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More than one million cataract surgeries, most with implantation of intraocular lenses, are performed in the United States each year. The early data on the United States Air Force's prospective study on the use of these surgical techniques in its military flyers are presented. From 1979 to 1990, 23 military aviators were evaluated by the United States Air Force School of Aerospace Medicine (USAFSAM) after cataract extraction with intraocular lens implantation. Their USAFSAM evaluation records were reviewed. Long-term follow-up (greater than 3 years) was available on only 3 subjects. All 23 subject were male Caucasians, with a mean age of 43 years. Ninety-one percent of the subjects were pilots, and, of these, 8 were qualified in high-performance aircraft. There were a total of 28 eyes, 86 percent (24) of which had received extracapsular cataract extractions (ECCE) with posterior chamber lenses. Best-corrected, postoperative vision was 20/20 or better in 100 percent of the eyes. Posterior capsule opacification occurred in 60 percent of the ECCE eyes, with one-third of those requiring Nd:YAG laser capsulotomies. Only one aviator was disqualified from flying duties for ocular reasons, a visually-qualified-to-fly rate of 96 percent. Eight aviators have actually flown since surgery. Although follow-up was short, the initial results are very encouraging. Author

N91-25617# Rigshospitalet, Copenhagen (Denmark). Dept. of Aviation Medicine.

CONTRAST SENSITIVITY AND GLARE FOLLOWING KERATOTOMY **c52**

Steen Tinning *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 3 p (For primary document see N91-25602 17-54)

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During the later years radial keratotomy has been proposed as a possibility for young myops to obtain adequate visual acuity to fulfill the visual requirements for military pilots. Post keratotomy applicants are never the less not usually accepted as pilots, due to reports describing reduced visual functions, increased sensitivity to glare, and unstable refraction following keratotomy. With the purpose to evaluate the visual problems following keratotomy, a number of postkeratotomy applicants has been referred to the eye-clinic at the Department of Aviation Medicine for extended eye-examination. Refraction was stable in all eyes but one. The visual functions at low illumination was reduced in one third of the eyes, and more than half of the eyes had reduced contrast sensibility during radial glare. It is generally advised not to accept postkeratotomy patients as pilots. Demonstrated stability of refraction and acceptable visual function during glare and reduced illumination should be regarded as minimum requirement, if a postkeratotomy patient is to be accepted as an aviator. Author

N91-25618# Institute of Ophthalmology, London (England). Dept. of Clinical Ophthalmology.

A SURVEY OF COLOUR DISCRIMINATION IN GERMAN OPHTHALMOLOGISTS: CHANGES ASSOCIATED WITH THE USE OF LASERS AND OPERATING MICROSCOPES **c52**

G. B. Arden, T. Berninger, C. R. Hogg, and E. Lund (Munich Eye Hospital, Germany, F.R.) *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 6 p Sponsored in part by Wellcome Trust and Wolfson Foundation (For primary document see N91-25602 17-54)

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Color vision tests were performed on 211 German ophthalmologists during their annual meeting at Essen. The subjects also filled in detailed questionnaires about their use of lasers and operating microscopes, and their ocular and general health. It was found that compared to those doctors who do not use lasers or operating microscopes, 33 percent of those who do have decreased color discrimination, for colors in a tritan color-confusion axis (greater than 2SD above normal). There is a relationship between number of patients treated and the degree of threshold elevation. Thirty hours of use of the operating microscope produces an increase in tritan threshold equivalent to 1 panretinal photocoagulation. After treating between 1000 to 10000 patients with Argon lasers, the average color threshold will be greater than 2SD above the normal mean. There is an important additional source of variation of color vision in surgeons who use lasers, due to to a factor which apparently offers protection against light hazard. Author

N91-25619# School of Aerospace Medicine, Brooks AFB, TX. Human Systems Div.

MEDICAL MANAGEMENT OF COMBAT LASER EYE INJURIES **c52**

Robert P. Green, Jr., Robert M. Cartledge, Frank E. Cheney, and Arthur R. Menendez *In* AGARD, Ocular Hazards in Flight and Remedial Measures May 1991 7 p (For primary document see N91-25602 17-54)

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The rapid growth of laser science and engineering has resulted in an increased use of lasers by the military. It is likely that in future engagements lasers will be used directly against the forces, and their effects on the health and mission performance of the aircrews are of particular concern. Since the optics of the eye can increase the retinal irradiance by a factor of 100,000 times over that which is incident at the cornea, the retina is especially vulnerable. Laser range finders and target designators are used in military operations, and energy inputs from these and other potential laser sources are sufficient to produce significant eye injury at distances of 1 km or more. Glare and flashblindness, which are temporary visual effects caused by visible lasers, are present for laser energies considerably below the damage threshold and can, therefore, interfere with mission performance at considerable longer range. Aircrews partially protected by windscreens and canopies are still at risk from near infrared and visible lasers, while other personnel, such as air base ground defense forces, are additionally at risk from ultraviolet and far infrared lasers. Patients' symptoms from laser exposure will vary depending upon the power and wavelength of the laser, the structure of the eye affected, how close the exposure was to the visual axis, and the extent of the temporary or permanent effects on visual structures. Since most medical personnel in the field have never previously dealt with a patient who has had a laser exposure, a report which provides background information on lasers and guidance on handling these patients was written. Author

55 SPACE BIOLOGY

Includes exobiology; planetary biology; and extraterrestrial life.

No abstracts in this category.

59 MATHEMATICAL AND COMPUTER SCIENCES (GENERAL)

No abstracts in this category.

60 COMPUTER OPERATIONS AND HARDWARE

Includes hardware for computer graphics, firmware, and data processing.

For components see *33 Electronics and Electrical Engineering.*

N91-25620# Geological Survey, Denver, CO.
SELECTED PAPERS IN THE APPLIED COMPUTER SCIENCES, 1990
Denise A. Wiltshire, ed. 1990 73 p
(PB91-141689; USGS-Bull-1908; LC-89-600309) Avail: NTIS HC/MF A04 CSCL 09B

A compendium of papers reports on the technical advances in the applied computer sciences that were developed to support Earth science research. Topics covered include applications of user-supplied transformations in computer graphics programs, linking digital technology to printing technology for producing production quality color graphics, generating color separations of geologic maps on the computer, digital spatial data technology and applications, radon potential defined by exploratory data analysis and geographic information systems, and automation of data systems. Author

N91-25621*# Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
REVIEW OF ESTELLE AND LOTOS WITH RESPECT TO CRITICAL COMPUTER APPLICATIONS
Rodney L. Bown May 1991 44 p
(Contract NCC9-16)
(NASA-CR-188596; NAS 1.26:188596) Avail: NTIS HC/MF A03 CSCL 09B

Man rated NASA space vehicles seem to represent a set of ultimate critical computer applications. These applications require a high degree of security, integrity, and safety. A variety of formal and/or precise modeling techniques are becoming available for the designer of critical systems. The design phase of the software engineering life cycle includes the modification of non-development components. A review of the Estelle and LOTOS formal description languages is presented. Details of the languages and a set of references are provided. The languages were used to formally describe some of the Open System Interconnect (OSI) protocols. Author

N91-25622*# Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
T ON THE CRAY X/MP Final Report
Paul Hudak (Yale Univ., New Haven, CT.) Apr. 1991 8 p
(Contract NCC9-16)
(NASA-CR-188590; NAS 1.26:188590) Avail: NTIS HC/MF A02 CSCL 09B

This research was aimed at porting the T programming language, a dialect of LISP, to the Cray X/MP computer. The effort involved research into systems engineering and software engineering problems related not only to compiler design and implementation, but also to parallel computation, the X/MP being a shared-memory multiprocessor. Porting also involved the sub-tasks of retargeting the assembler, code-generator, and run-time system. A reasonably effective porting methodology that is relatively straight forward, although more difficult than table-driven approaches, has been developed. The run-time system was not ported, and thus the T programs cannot be run without explicit linking of the required run-time support. The run-time performance gain achieved in generated code was found to be disappointing. Recommendations for the achievement of higher performance are given. L.K.S.

N91-25623*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INTRODUCTION TO THE LaRC CENTRAL SCIENTIFIC COMPUTING COMPLEX
John N. Shoosmith Apr. 1991 49 p
(NASA-TM-104092; NAS 1.15:104092) Avail: NTIS HC/MF A03 CSCL 09B

The computers and associated equipment that make up the Central Scientific Computing Complex of the Langley Research Center are briefly described. The electronic networks that provide access to the various components of the complex and a number of areas that can be used by Langley and contractors staff for special applications (scientific visualization, image processing, software engineering, and grid generation) are also described. Flight simulation facilities that use the central computers are described. Management of the complex, procedures for its use, and available services and resources are discussed. Author

61 COMPUTER PROGRAMMING AND SOFTWARE

Includes computer programs, routines, alogorithms, and specific applications, e.g., CAD/CAM.

N91-25624*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
GUIDANCE, NAVIGATION, AND CONTROL SUBSYSTEM EQUIPMENT SELECTION ALGORITHM USING EXPERT SYSTEM METHODS
Cheryl L. Allen Washington May 1991 12 p
(NASA-TP-3082; L-16896; NAS 1.60:3082) Avail: NTIS HC/MF A03 CSCL 09B

Enhanced engineering tools can be obtained through the integration of expert system methodologies and existing design software. The application of these methodologies to the spacecraft design and cost model (SDCM) software provides an improved technique for the selection of hardware for unmanned spacecraft subsystem design. The knowledge engineering system (KES) expert system development tool was used to implement a smarter equipment section algorithm than that which is currently achievable through the use of a standard data base system. The guidance, navigation, and control subsystems of the SDCM software was chosen as the initial subsystem for implementation. The portions of the SDCM code which compute the selection criteria and constraints remain intact, and the expert system equipment selection algorithm is embedded within this existing code. The architecture of this new methodology is described and its implementation is reported. The project background and a brief overview of the expert system is described, and once the details of the design are characterized, an example of its implementation is demonstrated. Author

N91-25625*# Vigyan Research Associates, Inc., Hampton, VA.
RULE GROUPINGS: A SOFTWARE ENGINEERING APPROACH TOWARDS VERIFICATION OF EXPERT SYSTEMS
Mala Mehrotra Washington NASA May 1991 112 p
(Contract NAS1-18585)
(NASA-CR-4372; NAS 1.26:4372; HQ91-015) Avail: NTIS HC/MF A06 CSCL 09B

Currently, most expert system shells do not address software engineering issues for developing or maintaining expert systems. As a result, large expert systems tend to be incomprehensible, difficult to debug or modify and almost impossible to verify or validate. Partitioning rule based systems into rule groups which reflect the underlying subdomains of the problem should enhance the comprehensibility, maintainability, and reliability of expert system software. Attempts were made to semiautomatically structure a CLIPS rule base into groups of related rules that carry the same type of information. Different distance metrics that capture relevant information from the rules for grouping are discussed. Two clustering algorithms that partition the rule base into groups of related rules are given. Two independent evaluation criteria are developed to measure the effectiveness of the grouping strategies. Results of the experiment with three sample rule bases are presented. Author

N91-25626*# Softech, Inc., Houston, TX.
A RESEARCH REVIEW OF QUALITY ASSESSMENT FOR SOFTWARE
30 Apr. 1991 36 p Prepared in cooperation with Houston Univ., Clear Lake, TX Prepared for MountainNet, Dellslow, WV
(Contract NCC9-16; Proj. RICIS SE-18)
(NASA-CR-188240; NAS 1.26:188240; ADANET-FD-R/T-086-0)
Avail: NTIS HC/MF A03 CSCL 09B

Measures were recommended to assess the quality of software submitted to the AdaNet program. The quality factors that are important to software reuse are explored and methods of evaluating those factors are discussed. Quality factors important to software reuse are: correctness, reliability, verifiability, understandability, modifiability, and certifiability. Certifiability is included because the documentation of many factors about a software component such as its efficiency, portability, and development history, constitute a class for factors important to some users, not important at all to other, and impossible for AdaNet to distinguish between a priori. The quality factors may be assessed in different ways. There are a few quantitative measures which have been shown to indicate software quality. However, it is believed that there exists many factors that indicate quality and have not been empirically validated due to their subjective nature. These subjective factors are characterized by the way in which they support the software engineering principles of abstraction, information hiding, modularity, localization, confirmability, uniformity, and completeness. Author

N91-25627# Georgia State Univ., Atlanta.
ASSESSMENT AND DEVELOPMENT OF SOFTWARE ENGINEERING TOOLS Final Report
Sue Conger, Martin Fraser, Ross Gagliano, Kuldeep Kumar, and Ephraim McLean 16 Jan. 1991 35 p
(Contract DAKF11-89-C-0014)
(AD-A233471; ASQB-GB-90-015) Avail: NTIS HC/MF A03 CSCL 12/5

The research began with the feasibility study and preliminary design of the Intelligent TestBed (ITB). The final technical report describes the motivation for, as well as the design and development of, the ITB. The goal of the ITB is to provide a capability to categorize and associate phases of the systems development life cycle with software methodologies and Computer Aided Software Engineering Tools. By automatically linking phases to tools, the ITB could benefit two different groups of users. First, researchers and developers can determine the availability, feasibility, and similarity of software tools that track systems development and maintenance. Second, managers and analysts, who may have no particular preferences for methods or tools, will be able to assimilate advancements in the several fields in addition to possessing the means to compare available products. GRA

N91-25628# Federal Aviation Administration, Atlantic City, NJ.
NAS OPERATIONAL TEST AND EVALUATION (OT/E)/INTEGRATION OF THE INTERIM MONITOR AND CONTROL SOFTWARE (IMCS) TEST PROCEDURES
Richard VanSuetendael Jun. 1991 136 p
(DOT/FAA/CT-TN90/43) Avail: NTIS HC/MF A07

The procedures used for the National Airspace System (NAS) Operational Test and Evaluation (OT and E)/Integration of the Interim Monitor and Control Software (IMCS). As test director, ACN-230 conducted NAS OT and E integration testing at the FAA Technical Center. The purpose of the test is to verify that the IMCS version PCB0703 functions properly in an integrated Maintenance Management System (MMS)/IMSC environment, and that all applicable NAS requirements are fulfilled. Author

N91-25629*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
A SCHEME FOR BANDPASS FILTERING MAGNETOMETER MEASUREMENTS TO RECONSTRUCT TETHERED SATELLITE SKIPROPE MOTION
M. E. Polites Washington Jun. 1991 25 p
(NASA-TP-3123; M-663; NAS 1.60:3123) Avail: NTIS HC/MF A03 CSCL 09B

A scheme is presented for reconstructing tethered satellite skiprope motion by ground processing of satellite magnetometer measurements. The measurements are modified based on ground knowledge of the earth's magnetic field and passed through bandpass filters tuned to the skiprope frequency. Simulation results are presented which verify the scheme and show it to be quite robust. The concept is not just limited to tethered satellites. Indeed, it can be applied wherever there is a need to reconstruct the coning motion of a body about a known axis, given measurements of a known vector in body-fixed axes. Author

N91-25630*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
GRID3D-v2: AN UPDATED VERSION OF THE GRID2D/3D COMPUTER PROGRAM FOR GENERATING GRID SYSTEMS IN COMPLEX-SHAPED THREE-DIMENSIONAL SPATIAL DOMAINS
E. Steinthorsson, T. I-P. Shih (Carnegie-Mellon Univ., Pittsburgh, PA.), and R. J. Roelke Jun. 1991 111 p
(NASA-TM-103766; E-6028; NAS 1.15:103766) Avail: NTIS HC/MF A06 CSCL 09B

In order to generate good quality systems for complicated three-dimensional spatial domains, the grid-generation method used must be able to exert rather precise controls over grid-point distributions. Several techniques are presented that enhance control of grid-point distribution for a class of algebraic grid-generation methods known as the two-, four-, and six-boundary methods. These techniques include variable stretching functions from bilinear interpolation, interpolating functions based on tension splines, and normalized K-factors. The techniques developed in this study were incorporated into a new version of GRID3D called GRID3D-v2. The usefulness of GRID3D-v2 was demonstrated by using it to generate a three-dimensional grid system in the coolent passage of a radial turbine blade with serpentine channels and pin fins. Author

N91-25631*# Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
REAL-TIME FUZZY INFERENCE BASED ROBOT PATH PLANNING Final Report
Peter J. Pacini and Jon S. Teichrow (Togai Infralogic, Inc., Irvine, CA.) 17 Aug. 1990 17 p
(Contract NCC9-16; Proj. AI-13)
(NASA-CR-188598; NAS 1.26:188598) Avail: NTIS HC/MF A03 CSCL 09B

This project addresses the problem of adaptive trajectory generation for a robot arm. Conventional trajectory generation involves computing a path in real time to minimize a performance measure such as expended energy. This method can be computationally intensive, and it may yield poor results if the trajectory is weakly constrained. Typically some implicit constraints are known, but cannot be encoded analytically. The alternative approach used here is to formulate domain-specific knowledge, including implicit and ill-defined constraints, in terms of fuzzy rules. These rules utilize linguistic terms to relate input variables to output variables. Since the fuzzy rulebase is determined off-line, only high-level, computationally light processing is required in real time. Potential applications for adaptive trajectory generation include missile guidance and various sophisticated robot control tasks, such as automotive assembly, high speed electrical parts insertion, stepper alignment, and motion control for high speed parcel transfer systems. Author

N91-25632*# Softech, Inc., Houston, TX.
SOFTWARE REUSE ISSUES AFFECTING AdaNET
John G. McBride 14 Jul. 1989 14 p Prepared for Houston Univ., Clear Lake, TX
(Contract NCC9-16)
(NASA-CR-188597; NAS 1.26:188597) Avail: NTIS HC/MF A03 CSCL 09B

The AdaNet program is reviewing its long-term goals and strategies. A significant concern is whether current AdaNet plans adequately address the major strategic issues of software reuse technology. The major reuse issues of providing AdaNet services that should be addressed as part of future AdaNet development are identified and reviewed. Before significant development proceeds, a plan should be developed to resolve the aforementioned issues. This plan should also specify a detailed approach to develop AdaNet. A three phased strategy is recommended. The first phase would consist of requirements analysis and produce an AdaNet system requirements specification. It would consider the requirements of AdaNet in terms of mission needs, commercial realities, and administrative policies affecting development, and the experience of AdaNet and other projects promoting the transfer software engineering technology. Specifically, requirements analysis would be performed to better understand the requirements for AdaNet functions. The second phase would provide a detailed design of the system. The AdaNet should be designed with emphasis on the use of existing technology readily available to the AdaNet program. A number of reuse products are available upon which AdaNet could be based. This would significantly reduce the risk and cost of providing an AdaNet system. Once a design was developed, implementation would proceed in the third phase. Author

N91-25633*# Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
NON-DEVELOPMENTAL ITEM COMPUTER SYSTEMS AND THE MALICIOUS SOFTWARE THREAT
Rodney L. Bown Apr. 1991 17 p
(Contract NCC9-16)
(NASA-CR-188595; NAS 1.26:188595) Avail: NTIS HC/MF A03 CSCL 09B

The following subject areas are covered: a DOD development system - the Army Secure Operating System; non-development commercial computer systems; security, integrity, and assurance of service (SI and A); post delivery SI and A and malicious software; computer system unique attributes; positive feedback to commercial computer systems vendors; and NDI (Non-Development Item) computers and software safety. Author

N91-25634*# Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
SOFTWARE ENGINEERING ETHICS
Rodney L. Bown Apr. 1991 16 p
(Contract NCC9-16)
(NASA-CR-188594; NAS 1.26:188594) Avail: NTIS HC/MF A03 CSCL 09B

Software engineering ethics is reviewed. The following subject areas are covered: lack of a system viewpoint; arrogance of PC DOS software vendors; violation od upward compatibility; internet worm; internet worm revisited; student cheating and company hiring interviews; computing practitioners and the commodity market; new projects and old programming languages; schedule and budget; and recent public domain comments. Author

N91-25635*# Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
DISCRETE MATHEMATICS, FORMAL METHODS, THE Z SCHEMA AND THE SOFTWARE LIFE CYCLE
Rodney L. Bown Apr. 1991 30 p
(Contract NCC9-16)
(NASA-CR-188593; NAS 1.26:188593) Avail: NTIS HC/MF A03 CSCL 09B

The proper role and scope for the use of discrete mathematics and formal methods in support of engineering the security and integrity of components within deployed computer systems are discussed. It is proposed that the Z schema can be used as the specification language to capture the precise definition of system and component interfaces. This can be accomplished with an object oriented development paradigm. Author

N91-25636*# Knowledge Based Systems, Inc. College Station, TX.
FRAMEWORK PROGRAMMABLE PLATFORM FOR THE ADVANCED SOFTWARE DEVELOPMENT WORKSTATION. INTEGRATION MECHANISM DESIGN DOCUMENT
Richard J. Mayer, Thomas M. Blinn, Paula S. D. Mayer, Uday Reddy, Keith Ackley, and Mike Futrell 17 Jun. 1991 75 p Prepared for Houston Univ., Clear Lake, TX
(Contract NCC9-16)
(NASA-CR-188592; NAS 1.26:188592) Avail: NTIS HC/MF A04 CSCL 09B

The Framework Programmable Software Development Platform (FPP) is a project aimed at combining effective tool and data integration mechanisms with a model of the software development process in an intelligent integrated software development

environment. Guided by this model, this system development framework will take advantage of an integrated operating environment to automate effectively the management of the software development process so that costly mistakes during the development phase can be eliminated. Author

N91-25637*# Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
FINAL REPORT
Louis A. DeAcetis (City Univ. of New York, Bronx.) Jan. 1991 18 p
(Contract NCC9-16)
(NASA-CR-188589; NAS 1.26:188589) Avail: NTIS HC/MF A03 CSCL 09B

The discussion of simulators and simulation, data aquisition and transmission and evaluation of Ada compilers and programming environments is presented. The following subject areas are covered: Bus 1553B software development; simulator development; and Ada programs to interface with C-software which drives PC-based interface cards for 1553B bus. Author

N91-25638*# Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
TRIP REPORTS: ISO WORKING GROUP 9, Ada, UNIFORMITY OF Ada APPLICATIONS RAPPORTEUR GROUP, AND Ada EUROPE
Sue LeGrand (Planning Research Corp., Washington, DC.) 24 Sep. 1990 8 p
(Contract NCC9-16)
(NASA-CR-188588; NAS 1.26:188588) Avail: NTIS HC/MF A02 CSCL 09B

Information on the Ada programming language is given. Topics covered include computer graphics, uniformity issues, Ada maintenance, and real time extensions. Author

N91-25639*# Softech, Inc., Houston, TX.
SUMMARY REPORT FOR THE ENGINEERING SCRIPT LANGUAGE (ESL)
28 Nov. 1990 73 p Prepared in cooperation with Houston Univ., Clear Lake, TX
(Contract NCC9-16)
(NASA-CR-188587; NAS 1.26:188587) Copyright Avail: NTIS HC/MF A04 CSCL 09B

The following subject areas are covered: ESL methodology concept; ESL specification; user interface description; engineering scripting language command statements specification; and recommendations for further research and development. Author

N91-25640*# Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
AN OVERVIEW OF SAFENET AND ITS IMPLICATIONS FOR AEROSPACE APPLICATIONS
George C. Collins and Rodney L. Bown Feb. 1991 19 p
(Contract NCC9-16)
(NASA-CR-188585; NAS 1.26:188585) Avail: NTIS HC/MF A03 CSCL 09B

The survivable, adaptable fiber optic embeddable network (SAFENET) is a draft standard for local area networking (LAN) developed by the Navy which, when adopted, will become a military standard. The standard is being developed for procurement specifications of computer resources to be used on ships and aircraft and has some of the real-time concerns that network standards for space vehicles have. Architecture and survivability are considered. It is noted that the token-ring LAN must implement the IEEE 802.5 recommended practice for dual ring reconfiguration, which is currently being reviewed for inclusion into the IEEE standard. A trunk coupling unit is used at each station to isolate a station from the ring in case of failure. Up to five stations can be bypassed in this fashion. Communication architecture has an OSI profile but differs from the standard concept of the seven layers by allowing alternate suits and breaking the layers into three groupings of services to allow for physical interfacing. It also provides several paths, even if only one profile is used. Management and synchronization protocols are discussed and security issues are addressed. Implications for aerospace applications are considered and it is projected that interoperability with the Navy and other U.S. Government systems may require SAFENET specifications for NASA systems. L.K.S.

N91-25641*# Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
EXPERT SYSTEM TRAINING AND CONTROL BASED ON THE FUZZY RELATION MATRIX Final Report
Jie Ren and T. B. Sheridan (Massachusetts Inst. of Tech., Cambridge.) 1 Jun. 1991 35 p
(Contract NCC9-16)
(NASA-CR-188605; NAS 1.26:188605) Avail: NTIS HC/MF A03 CSCL 09B

Fuzzy knowledge, that for which the terms of reference are not crisp but overlapped, seems to characterize human expertise. This can be shown from the fact that an experienced human operator can control some complex plants better than a computer can. Proposed here is fuzzy theory to build a fuzzy expert relation matrix (FERM) from given rules or/and examples, either in linguistic terms or in numerical values to mimic human processes of perception and decision making. The knowledge base is codified in terms of many implicit fuzzy rules. Fuzzy knowledge thus codified may also be compared with explicit rules specified by a human expert. It can also provide a basis for modeling the human operator and allow comparison of what a human operator says to what he does in practice. Two experiments were performed. In the first, control of liquid in a tank, demonstrates how the FERM knowledge base is elicited and trained. The other shows how to use a FERM, build up from linguistic rules, and to control an inverted pendulum without a dynamic model. Author

N91-25642 Stanford Univ., CA.
AN IDENTIFICATION ALGORITHM BASED ON SMOOTHING Ph.D. Thesis
Moshe Idan 1990 128 p
Avail: Univ. Microfilms Order No. DA9108844

An identification algorithm that is based on smoothing is presented. This is an off-line time domain identification procedure that can be classified as a maximum likelihood type algorithm in the presence of process and measurement noise. Parameter identification is a nonlinear programming problem. The suggested algorithm solves this problem by dividing it into two parts, each of which has an easier solution than the general one. The experimental data are smoothed with different sets of system parameters. The smoothed data include the smoothed estimates of the states, the process noise and the Language multipliers. These data are used to compute the gradients of the identification performance measure with respect to the system parameters. The system parameters are then updated using a quasi-Newton algorithm together with a numerical rank-two procedure for estimating the inverse of the Hessian matrix. The smoothing and parameter updates are repeated until the parameters have converged and the performance measure is minimized. This identification approach was previously presented for discrete linear time invariant systems. Identification algorithms for linear and nonlinear hybrid systems, that consists of continuous state space models and discrete measurement equations, are derived and tested with real flight test data. These algorithms are also extended to identify one set of parameters from several test runs. The multi-maneuver algorithm was used to extract the stability and control derivatives of the rigid body model of the DLR BO-105 research helicopter from flight test data. Both nonlinear and linear identification algorithms were used for data consistency checks of the Black Hawk UH-60 research helicopter flight test data, using nonlinear and linearized kinematics models. Author

N91-25643 Kansas Univ., Lawrence.
AN OPTIMAL POLE PLACEMENT GAIN SCHEDULING ALGORITHM USING OUTPUT FEEDBACK Ph.D. Thesis
Reiner Suikat 1990 177 p
Avail: Univ. Microfilms Order No. DA9110923

The development of an optimal gain scheduling method for pole placement using output feedback and the application of the method to an advanced flight control system are discussed. Conventionally a gain schedule is computed from gain matrices obtained at a number of design points using some curve fitting method. A curve fit is however unable to take the controller performance into account and hence may fail to produce acceptable results. The gain scheduling method developed in the current research solves this problem by minimizing a cost function which directly relates to the difference between the design eigenvalues and the actually achieved eigenvalues of the closed-loop system at all design points. This enables the method to place the eigenvalues more accurately than a gain schedule obtained from a curve fitting technique. Weights can be placed on all eigenvalues to improve the placement of particular poles. This output feedback pole placement gain schedule is then applied to a flight control system for an advanced research aircraft. The state vector is augmented by integrator and filter states to enhance the performance characteristics of the flight control system. Special consideration is given to the selection of design eigenvalues and eigenvectors for the additional states. Dissert. Abstr.

N91-25644*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
A MANUAL FOR PARTI RUNTIME PRIMITIVES, REVISION 1
Final Report
Raja Das, Joel Saltz, and Harry Berryman (Yale Univ., New Haven, CT.) May 1991 52 p
(Contract NAS1-18605; NSF ASC-88-19374)
(NASA-CR-187568; NAS 1.26:187568; ICASE-IR-17-Rev-1)
Avail: NTIS HC/MF A04 CSCL 09B

Primitives are presented that are designed to help users efficiently program irregular problems (e.g., unstructured mesh sweeps, sparse matrix codes, adaptive mesh partial differential equations solvers) on distributed memory machines. These primitives are also designed for use in compilers for distributed memory multiprocessors. Communications patterns are captured at runtime, and the appropriate send and receive messages are automatically generated. Author

N91-25645# National Aerospace Lab., Tokyo (Japan).
ON SYSTEM IDENTIFICATION USING HANKEL MATRICES BY THE TIME DOMAIN APPROACH
Isao Yamaguchi and Takashi Kida Oct. 1990 25 p In JAPANESE; ENGLISH summary
(NAL-TR-1084; ISSN-0389-4010) Avail: NTIS HC/MF A03

The theory and application of a method of system identification using Hankel matrices in the time domain are described. The Eigen-System Realization Algorithm (ERA) is a typical system realization method utilizing Hankel matrices. The method, however, assumes ideal impulse response. Here, a new iterative algorithm using the least square method is developed for practical applications in the space environment. Numerical examples for the ETS-VI structural model and ground based experiments on an air-bearing table attached by the flexible isogrid panel are carried out to demonstrate the validity of the new method. Author

N91-25646*# Virginia Univ., Charlottesville. Dept. of Computer Science.
SOFTWARE FAULT TOLERANCE USING DATA DIVERSITY
Annual Progress Report, 1 Apr. 1990 - 31 Mar. 1991
John C. Knight Jul. 1991 56 p
(Grant NAG1-1123)
(NASA-CR-188616; NAS 1.26:188616; UVA/528344/CS92-101)
Avail: NTIS HC/MF A04 CSCL 09B

Research on data diversity is discussed. Data diversity relies on a different form of redundancy from existing approaches to software fault tolerance and is substantially less expensive to implement. Data diversity can also be applied to software testing and greatly facilitates the automation of testing. Up to now it has been explored both theoretically and in a pilot study, and has been shown to be a promising technique. The effectiveness of data diversity as an error detection mechanism and the application of data diversity to differential equation solvers are discussed. Author

N91-25647*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
USING A GRAPHICAL PROGRAMMING LANGUAGE TO WRITE CAMAC/GPIB INSTRUMENT DRIVERS
Horacio Zambrana (Eloret Corp., Sunnyvale, CA.) and William Johanson May 1991 11 p
(NASA-TM-103849; A-91100; NAS 1.15:103849) Avail: NTIS HC/MF A03 CSCL 09B

To reduce the complexities of conventional programming, graphical software was used in the development of instrumentation drivers. The graphical software provides a standard set of tools (graphical subroutines) which are sufficient to program the most sophisticated CAMAC/GPIB drivers. These tools were used and instrumentation drivers were successfully developed for operating CAMAC/GPIB hardware from two different manufacturers: LeCroy and DSP. The use of these tools is presented for programming a LeCroy A/D Waveform Analyzer. Author

N91-25648# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Analysis, Algebra and Geometry.
HANDLING HYPERGEOMETRIC SERIES IN MAPLE
Tom H. Koornwinder Aug. 1990 18 p Submitted for publication Sponsored by Netherlands Organization for the Advancement of Research
(CWI-AM-R9014; ETN-91-99343) Copyright Avail: NTIS HC/MF A03

The standard procedures available in MAPLE 4.3 for handling hypergeometric series are discussed and evaluated. Some suggestions for improvement are given. A survey of the algorithms of Gosper and of Zeilberger for possibly evaluating a terminating series of hypergeometric type is given. ESA

N91-25649# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
AT LAST AN ISO/ISO C BINDING OF GKS
Miente Bakker Jun. 1990 8 p Submitted for publication Sponsored by Netherlands Organization for the Advancement of Research
(CWI-CS-R9022; ETN-91-99364) Copyright Avail: NTIS HC/MF A02

While GKS (Graphic Kernel System) was completed in 1985 and GKS-3D(2) (and PHIGS(3)) became international standard in 1988, none of their C bindings could be standardized, for the simple reason that the C language itself was not a standard. Instead, a host of de facto GKS/C bindings appeared. The idea of the ISO C bindings of GKS and the main features are outlined. ESA

N91-25650# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
SUBSTRING PARSING FOR ARBITRARY CONTEXT-FREE GRAMMARS
J. Rekers and J. W. C. Koorn (Amsterdam Univ., Netherlands) Aug. 1990 12 p Sponsored by Commission of the European Communities and Netherlands Organization for the Advancement of Research
(CWI-CS-R9037; ETN-91-99367) Copyright Avail: NTIS HC/MF A03

A substring recognizer for a language L determines whether a string s is a substring of a sentence in L. An algorithm for substring recognition is presented which accepts general context free grammars and uses the same parse tables as the parsing algorithm from which it was derived. Substring recognition is useful for 'noncorrecting' syntax error recovery and for incremental parsing. By extending the substring 'recognizer' with the ability to generate trees for the possible contextual completions of the substring, a substring parser is obtained which can be used in a syntax directed editor to complete fragments of sentences. ESA

N91-25651# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
QUANTIFIERS
D. Jan N. vanEijck Aug. 1990 18 p Submitted for publication Sponsored by Netherlands Organization for the Advancement of Research
(CWI-CS-R9038; ETN-91-99368) Copyright Avail: NTIS HC/MF A03

An overview of the treatment of the semantics of quantified expressions in natural language is presented. Aristotle's and Frege's theories of quantification are summarized and the relational perspective on quantifiers that forms the basis of most current accounts of quantifiers in natural language is outlined. General conditions on quantifier relations are given and several kinds of representations for quantifiers are discussed. The linguistic interest of relational properties such as symmetry and various forms of monotinicity is illustrated and the connection between quantifier theory and automata theory is outlined. Presuppositional, partial and adverbial quantifiers and the phenomenon of quantifier branching are discussed. ESA

N91-25652# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
DETERMINERS
D. Jan N. vanEijck Aug. 1990 12 p Submitted for publication Sponsored by Netherlands Organization for the Advancement of Research
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An overview of the treatment of the semantics of determiner expressions in natural language is presented. General properties of determiner denotations are listed. A semantic account of the distinction between definite, indefinite and quantifier determiners is given. The internal structure of determiners is addressed. A dynamic view on noun phrase and determiner interpretation, where unbounded anaphoric links are handled by interpreting the antecedent noun phrases as 'state changers', is outlined. ESA

N91-25653# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
AN INFINITARY CHURCH-ROSSER PROPERTY FOR NON-COLLAPSING ORTHOGONAL TERM REWRITING SYSTEMS
J. R. Kennaway, Jan Willem Klop, M. R. Sleep (East Anglia Univ., Norwich, England), and F. J. deVries Sep. 1990 15 p Sponsored by Commission of the European Communities and Netherlands Organization for the Advancement of Research
(CWI-CS-R9043; ETN-91-99373) Copyright Avail: NTIS HC/MF A03

For non collapsing, orthogonal, infinitary term rewriting systems, an inconditioned infinitary Church-Rosser property for strongly converging reductions is proved. The proof method extends to orthogonal term rewrite systems that contain non collapsing rules together with only one collapsing rule of the form I(X) onto x. ESA

N91-25654# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
GSE, A GENERIC SYNTAX-DIRECTED EDITOR
M. H. H. vanDijk (BSO/Automation Technology B.V., Utrecht, Netherlands) and J. W. C. Koorn Sep. 1990 20 p Sponsored by Commission of the European Communities and Netherlands Organization for the Advancement of Research
(CWI-CS-R9045; ETN-91-99375) Copyright Avail: NTIS HC/MF A03

GSE, a Generic Syntax directed Editor developed in the context of the GIPE project (Generation of Interactive Programming Environments) is described. GSE is generic, i.e., it can be used for any language for which the syntax has been specified. GSE is syntax directed, which means that it is aware of the syntax of the language in use and can thus assist both in building a syntically correct program and in checking and correcting the syntax of existing (parts of) programs. Free text editing and syntax directed editing are integrated in a transparent way. ESA

N91-25655# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
A FULLY ABSTRACT MODEL FOR CONCURRENT LOGIC LANGUAGES
Frank S. deBoer and Catuscia Palamidessi (Pisa Univ., Italy) Dec. 1990 27 p Sponsored by Commission of the European Communities; Netherlands Research and Education in Concurrency System; CNR; and Netherlands Organization for the Advancement of Research
(CWI-CS-R9046; ETN-91-99376) Copyright Avail: NTIS HC/MF A03

The main aim is to show that the nature of the communication mechanism of concurrent logic languages is essentially different from the classical paradigms of CCS and TCSP. A compositional semantics based on linear sequences is defined, while more complicated structures, like trees and failure sets, are needed to model compositionally CCS and TCSP. This semantics is proved to be fully abstract, namely that the information encoded by these sequences is necessary. The observation criterium consists of all the finite results, i.e., the computed constraint together with the termination mode (success, failure, or deadlock). The operations considered are the parallel composition of goals and the union of neatly intersecting programs. A compositional operational model delivering sequences of input output constraints is defined and a fully abstract denotational semantics is obtained by requiring additionally some closure conditions, that model the monotonic nature of communication in concurrent constraint languages. ESA

N91-25656# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
STUDIES IN PURE PROLOG: TERMINATION
Krzysztof R. Apt and Dino Pedreschi (Pisa Univ., Italy) Sep. 1990 28 p Submitted for publication Sponsored by Commission of the European Communities; CNR; and Netherlands Organization for the Advancement of Research
(CWI-CS-R9048; ETN-91-99378) Copyright Avail: NTIS HC/MF A03

A theoretical basis for studying termination of logic programs with the PROLOG selection rule is presented. To this end the class of 'left terminating' programs is studied. These are logic programs that terminate with the PROLOG selection rule for all ground goals. It is shown that various ways of defining semantics coincide for left terminating programs. A characterization of left terminating programs that provides a practical method of proving termination of the quicksort, permutation and mergesort programs for the desired class of goals. ESA

N91-25657# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
LOGGING AND RECOVERY IN PRISMA
C. A. vandenBerg and M. L. Kersten Sep. 1990 19 p Sponsored by Netherlands Organization for the Advancement of Research
(CWI-CS-R9049; ETN-91-99379) Copyright Avail: NTIS HC/MF A03

The recovery methods for main memory database systems are mostly based on maintaining a disk based log and checkpoint. The information written to the log usually consists of low level information, before/after images, or single tuple updates. The effect of writing higher level update information to the log is examined. This results in less logging overhead during normal processing, but an increased replay overhead during recovery. A cost model for analyzing the effect of higher level logging on the transaction throughput is introduced. The results of a performance analysis based on this cost model are presented. ESA

N91-25658# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
PERFORMANCE ANALYSIS OF A DYNAMIC QUERY PROCESSING SCHEME

M. L. Kersten, S. Shair-Ali, and C. A. vandenBerg Sep. 1990 24 p Sponsored by Netherlands Organization for the Advancement of Research and Stimuleringsprojectteam Informaticaonderzoek
(CWI-CS-R9050; ETN-91-99380) Copyright Avail: NTIS HC/MF A03

Traditional query optimizers produce a fixed query evaluation plan based on assumptions about data distribution and processor workloads. However, these assumptions may not hold at query execution time. A dynamic query processing scheme is proposed and the performance results obtained by simulation of a queuing network model of the proposed software architecture are presented. ESA

N91-25659# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
RETROSPECTIVE CREATION OF VIRTUAL ALTERNATIVE HIERARCHIES
Jan L. H. Rogier (Netherlands Organization for Applied Scientific Research TNO, Delft.) and Daan B. M. Otten Sep. 1990 15 p Sponsored by Netherlands Organization for the Advancement of Research
(CWI-CS-R9051; ETN-91-99381) Copyright Avail: NTIS HC/MF A03

An object oriented strategy to support the creation of geometric models is presented. These models are presented as part-whole hierarchies of objects. Creation of new models is done by copying and modifying previously existing models of parts of them. Past models are stored in the system's database and serve as prototypes for the new models. To support the selection of an appropriate prototype the system provides a view on its database presenting an is-a-hierarchy of object type definitions that depends on: the currently available models in the system's database; a functional specification that represents the designer's intentions; and a set of definitions that are used by the system to interpret a functional specification. From the hierarchy the user can either select an object type definition that might serve as a template for a new part or select one of the coast models from which an object type definition originates. Since the is-a hierarchy of object type definitions only exists virtually, is moreover directly controlled by the user and is highly flexible, as well as providing alternative hierarchies presenting alternative views on the system's database, the approach is called retrospective creation of virtual alternative hierarchies. ESA

N91-25660# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
A LAYERED SEMANTICS FOR A PARALLEL OBJECT-ORIENTED LANGUAGE
Pierre H. M. America (Philips Gloeilampenfabrieken N.V., Eindhoven, Netherlands) and Jan J. M. M. Rutten Oct. 1990 45 p Presented at REX/FOOL Worshop on the Foundations of Object-Oriented Languages, Noordwijkerhout, Netherlands, 1990 Submitted for publication Sponsored by Commission of the European Communities and Netherlands Organization for the Advancement of Research
(CWI-CS-R9052; ETN-91-99382) Copyright Avail: NTIS HC/MF A03

A denotational semantics for POOL, a Parallel Object-Oriented programming Language is developed. The main contribution of this semantics is an accurate mathematical model of the most important concept in object oriented programming: the object. This is achieved by structuring the semantics in layers working at three different levels: for statements, for objects, and for programs. For each of these levels, a specialized mathematical domain of processes is defined, which is used to assign a meaning to each language construct. This is done in the mathematical framework of complete metric spaces. Operators that translate between these domains are defined. At the program level, a precise definition of the observable input/output behavior of a particular program, which could be used at a later stage to decide the issue of full abstractness, is given. The semantic techniques are illustrated by first applying them to a toy language similar to CSP (Communicating Sequential Processes). ESA

N91-25661# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
THE MEANING OF NEGATIVE PREMISES IN TRANSITION SYSTEM SPECIFICATIONS
Roland N. Bol and Jan Friso Groote Oct. 1990 47 p Sponsored by Commission of the European Communities and Netherlands Organization for the Advancement of Research
(CWI-CS-R9054; ETN-91-99384) Copyright Avail: NTIS HC/MF A03

A general theory for the use of negative premises in the rules of Transition System Specifications (TSSs) is presented. A criterion that should be satisfied by a TSS in order to be meaningful, i.e. to unequivocally define a transition relation, is formulated. Powerful techniques for proving that a TSS satisfies this criterion are provided meanwhile constructing this transition relation. Both the criterion and the techniques originate from logic programming to which TSS's are close. An extensive comparison between them is given. The bisimulation relation induced by a TSS is shown to be a congruence, provided that it is in ntyft/ntyxt format and can be proved meaningful using the techniques. Previous conservativity theorems are extended. As a running example, the combined addition of priorities and abstraction to Basic Process Algebra (BPA) are studied. Under some reasonable conditions, it is shown that this TSS is indeed meaningful, which could not be shown by other methods. A sound and complete axiomatization for this example is provided. ESA

N91-25662# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
FORMAL SEMANTICS
D. Jan N. vanEijck Oct. 1990 21 p Submitted for publication Sponsored by Netherlands Organization for the Advancement of Research
(CWI-CS-R9055; ETN-91-99385) Copyright Avail: NTIS HC/MF A03

An introduction to formal theories of meaning for natural language is presented. The process of composition of meaning and the relations between the concepts of meaning, inference and truth are presented, and contextual aspects of meaning are discussed. The emerging perspective of a dynamic theory of meaning is outlined. ESA

N91-25663# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
IDDL: A LANGUAGE FOR INTELLIGENT INTERACTIVE INTEGRATED CAD SYSTEMS
Paul J. Veerkamp, P. Bernus, P. J. W. tenHagen, and V. Akman (Bilkent Univ., Ankara, Turkey) Oct. 1990 20 p Sponsored by Netherlands Organization for the Advancement of Research
(CWI-CS-R9056; ETN-91-99386) Copyright Avail: NTIS HC/MF A03

IDDL (Integrated Data Description Language), a language designed for intelligent CAD (Computer Aided Design) systems is presented. IDDL consists of two main parts. It provides a database integrating object oriented programming and logic programming paradigms for a design object description. These two separate parts of the database are connected through the means of functions. Representational constructs of the language are selected according to special needs od data representation in CAD. These include several non classical logic features of the language. IDDL provides rule based scenarios for the design process description to manipulate the database in a forward reasoning manner by executing these scenarios. These scenarios also provide a mechanism to maintain multiple worlds of the design database. This reflects the evolutionary aspect of the design development. The application of these concepts to design process representation is presented. ESA

N91-25664# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
MULTIPLE WORLDS IN AN INTELLIGENT CAD SYSTEM
Paul J. Veerkamp Oct. 1990 14 p Sponsored by Netherlands Organization for the Advancement of Research
(CWI-CS-R9057; ETN-91-99387) Copyright Avail: NTIS HC/MF A03

Three concepts, a general design model based on stepwise refinement, a design object model evaluation scheme to interpret the design object model and to evaluate it, and the multi-world mechanism are introduced. The multi-world mechanism stems from the first two concepts. It enables the designer to create worlds. Worlds are alternative descriptions of the design object from different view points. A distinction is made between dependent and independent worlds. ESA

N91-25665# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
NONWELLFOUNDED SETS AND PROGRAMMING LANGUAGE SEMANTICS
Jan J. M. M. Rutten Nov. 1990 20 p Sponsored by Commission of the European Communities and Netherlands Organization for the Advancement of Research
(CWI-CS-R9063; ETN-91-99393) Copyright Avail: NTIS HC/MF A03

For a large class of transition systems that are defined by specifications in the structural operational semantics style, it is shown how these induce a compositional semantics. The main difference with earlier work on this subjecty is the use of a nonstandard set theory that is based on Aczel's anti foundation axiom. Solving recursive domain equations in this theory leads to solutions that contain nonwellfounded elements. These are particularly useful for justifying recursive definitions, both of semantic operators and semantic models. The use of nonwellfounded sets further allows for the construction of compositional models for a larger class of transition systems that in the setting of complete metric spaces, which was used before. ESA

N91-25666# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
A META-ENVIRONMENT FOR GENERATING PROGRAMMING ENVIRONMENTS
P. Klint (Amsterdam Univ., Netherlands) Nov. 1990 25 p Presented at METEOR Workshop on Methods Based on Formal Specifications, Mierlo, Netherlands, Sep. 1989 Submitted for publication Sponsored by Commission of the European Communities and Netherlands Organization for the Advancement of Research
(CWI-CS-R9064; ETN-91-99394) Copyright Avail: NTIS HC/MF A03

The design and implementation of a meta environment (a development environment for formal language definitions) based on the ASF (Algebraic Specification Formalism) and SDF (Syntax Definition Formalism) are described. This meta environment is currently being implemented as part of the Centaur system and is, at least partly, obtained by applying environment generation techniques to the language definition formalism itself. A central problem is providing fully interactive editing of modular language definitions such that modifications made to the language definition during editing can be translated immediatly to modifications in the programming environment generated from the original language defnition. Therefore, some of the issues addressed are the treatment of formalism with user definable syntax, and incremental program generation techniques. ESA

N91-25667# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
MANIFOLD: A LANGUAGE FOR SPECIFICATION OF INTER-PROCESS COMMUNICATION
Farhad Arbab and Ivan Herman Nov. 1990 19 p Submitted for publication Sponsored by Netherlands Organization for the Advancement of Research
(CWI-CS-R9065; ETN-91-99395) Copyright Avail: NTIS HC/MF A03

Management of the communications among a set of concurrent processes arises in many applications and is a central concern in parallel computing. A language whose sole purpose is to describe and manage complex interconnections among independent, concurrent processes is introduced. In the underlying paradigm of this language, MANIFOLD, the primary concern is not with what functionality the individual processes in a parallel system provide. Instead, the emphasis is on how these processes are interconnected and how theory interaction patterns change during the execution life of the system. It is interesting that the conceptual model behind the MANIFOLD language immediately leads to a very simple, but nonconventional model of computation. Contrary to most other models, computation in MANIFOLD is built out of communications. As such it advocates a view point reminiscent of the connectionist view: that all (conventional) computation can be expressed as interactions. ESA

N91-25668# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
EXAMPLES IN MANIFOLD
Farhad Arbab and Ivan Herman Nov. 1990 30 p Sponsored by Netherlands Organization for the Advancement of Research
(CWI-CS-R9066; ETN-91-99396) Copyright Avail: NTIS HC/MF A03

An insight into the use of the MANIFOLD system is given by presenting a few short examples. The overall description and the more formal syntax and semantics of MANIFOLD are given in separate documents. The MANIFOLD model of computation is outlined. Examples include simple copy, action synchronization, counter, control structures, the repeater, resource management and bucket sorting. Although the primary purpose of MANIFOLD is to manage communications, the same language also expresses computation in terms of communication. ESA

N91-25669# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
DISCOURSE REPRESENTATION THEORY
D. Jan N. vanEijck Nov. 1990 13 p Submitted for publication Sponsored by Netherlands Organization for the Advancement of Research
(CWI-CS-R9067; ETN-91-99397) Copyright Avail: NTIS HC/MF A03

An introduction to discourse representation theory, a theory for the dynamic interpretation of natural language, is represented. The problem of establishing links between anaphoric pronouns and their antecedents which the theory sets out to solve is introduced. The basic ideas of the theory are listed, various later extensions are discussed, and the relation to partial interpretation of language is outlined. ESA

N91-25670# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
REPRESENTATION AND IMPLEMENTATION OF DESIGN KNOWLEDGE FOR INTELLIGENT CAD: IMPLEMENTATION ASPECTS
Deyi Xue, Takashi Kiriyama, Tetsuo Tomiyama (Tokyo Univ., Japan), and Paul J. Veerkamp Dec. 1990 19 p Sponsored by Netherlands Organization for the Advancement of Research
(CWI-CS-R9071; ETN-91-99401) Copyright Avail: NTIS HC/MF A03

The metamodel mechanism, one of the features of IDDL (Integrated Data Description Language) is presented. IDDL is a programming language with features of object oriented programming and logic programming. It is a knowledge representation language especially designed for implementing intelligent CAD (Computer Aided Design) systems. It incorporates a metamodel mechanism, which provides a means to represent the design object model a context independent way. From a metamodel aspect models can be derived. Aspect models are interpretations of the metamodel in a certain context. Examples

of an aspect model are a kinematic model and a geometric model. An informal introduction to IDDL and an extensive example of the usage of the metamodel are given. ESA

N91-25671# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
DERIVING INCREMENTAL IMPLEMENTATIONS FROM ALGEBRAIC SPECIFICATIONS
E. A. vanderMeulen Dec. 1990 23 p Sponsored by Commission of the European Communities and Netherlands Organization for the Advancement of Research
(CWI-CS-R9072; ETN-91-99402) Copyright Avail: NTIS HC/MF A03

A technique for deriving incremental implementations for a subclass of algebraic specifications, namely, conditional well presented primitive recursive schemes is presented. Concepts of the translation of well presented primitive recursive schemes to strongly noncircular attribute grammars, storing results of functions applications and their parameters as attributes in an abstract syntax tree of the first argument of the function in question, are used. An attribute dependency graph is used to guide incremental evaluation. The valuation technique is based on a leftmost innermost rewrite strategy. The technique is extended to conditional well presented primitive recursive schemes. Whereas in the nonconditional case attribute dependency graphs are constructed before evaluating a term, when working with conditional equations, the attribute dependency graph is constructed upon evaluation. The class of well presented primitive recursive schemes is a very natural one for specifying the static semantics of languages. Allowing conditions to equations in a primitive recursive scheme is the first step in extending this class to one in which the dynamic semantics of languages can de described as well. ESA

N91-25672# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
TERM REWRITING SYSTEMS
Jan Willem Klop Dec. 1990 135 p Submitted for publication Sponsored by Netherlands Organization for the Advancement of Research
(CWI-CS-R9073; ETN-91-99403) Copyright Avail: NTIS HC/MF A07

Term Rewriting Systems (TRS) play an important role in various areas, such as abstract data type specifications, implementations of functional programming languages and automated deduction. Several of the basic concepts and facts for TRSs are introduced. The following are discussed in detail: abstract reduction systems; general term rewriting systems including an account of Knuth-Bendix completion and (E-)unification; orthogonal TRSs and reduction strategies; strongly sequential orthogonal TRSs. Some extended rewrite formats are introduced: conditional TRSs and combinatory reduction systems. The emphasis throughout is on providing information of syntactic nature. ESA

N91-25673# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
EDITING OBJECTS OF HIERARCHICAL STRUCTURED DRAWING
Jantien vanderVegt Dec. 1990 18 p Sponsored by Netherlands Organization for the Advancement of Research
(CWI-CS-R9074; ETN-91-99404) Copyright Avail: NTIS HC/MF A03

Current interactive drawing programs are discussed. An approach which allows the user to select and edit objects at each level of the hierarchy is presented. The main concept, 'a current object', allows the user to travel through the hierarchical structure of the drawing in order to select objects at each level of the hierarchy. This approach not only enables the users to use the hierarchical structure that corresponds to their mental representation, but also eliminates some inconsistencies in the current drawing programs. A drawing program was made in which the proposed way of 'structure editing' was realized. The first impressions of this implementation are discussed. ESA

N91-25674# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
LOOP CHECKING AND NEGATION
Roland N. Bol Dec. 1990 35 p Sponsored by Commission of the European Communities and and Netherlands Organization for the Advancement of Research
(CWI-CS-R9075; ETN-91-99405) Copyright Avail: NTIS HC/MF A03

The concept of loop checking is extended from positive programs to locally stratified programs. Such an extension is not straightforward: the introduction of negation requires a (re) consideration of the choice of semantics, the description of a related search space and new soundness and completeness results handling floundering in a satisfactory way. Nevertheless an extension is achieved that allows generalization of the loop checking mechanisms from positive programs to locally stratified programs; while preserving most soundness and completeness results. The conclusion is that negative literals cannot give rise to loops, and must be simply ignored. ESA

N91-25675# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.
BASIS: A DATA STRUCTURE FOR ADAPTIVE MULTIGRID COMPUTATIONS
P. W. Hemker, H. T. M. vanderMaarel, and C. T. H. Everaars Aug. 1990 42 p Sponsored in part by Netherlands Organization for the Advancement of Research
(Contract AERO-0003-C)
(CWI-NM-R9014; ETN-91-99407) Copyright Avail: NTIS HC/MF A03

A data structure and basic algorithms that can be used for the implementation of adaptive multigrid procedures are described. In particular, it is applied in a program for the solution of the Euler and compressible Navier-Stokes equations. The basic elements of the grid are rectangular cells that fit in a QUAD tree structure. A PASCAL prototype implementation is given and a FORTRAN implementation is also available. ESA

N91-25676# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.
NUMVEC FORTRAN LIBRARY MANUAL. CHAPTER: BASIC LINEAR ALGEBRA. ROUTINE: MATMUL. CHAPTER: SIMULTANEOUS LINEAR EQUATIONS. ROUTINES: BIDIAGL AND BIDIAGU
J. J. F. M. Schlichting Sep. 1990 9 p Sponsored by Netherlands Organization for the Advancement of Research
(CWI-NM-R9017; ETN-91-99410) Copyright Avail: NTIS HC/MF A02

The following NUMVEC FORTRAN library routines (developed for the Cyber 205) are described: MATMUL performs matrix matrix multiplication on full matrices, by means of 64 fold unrolling in the usual vector update method; BIDIAGL and BIDIAGU solve systems of linear equations where the matrix is lower and upper bidiagonal respectively. In order to obtain maximal performance on the Cyber 205 (120 MFLOPS for MATMUL and 18 MFLOPS for BIDIAGL and BIDIAGU) these routines were written in the assembly language META. ESA

N91-25677# Oak Ridge National Lab., TN.
A SUPERNODAL CHOLESKY FACTORIZATION ALGORITHM FOR SHARED-MEMORY MULTIPROCESSORS
E. G. Ng and B. W. Peyton Apr. 1991 32 p
(Contract DE-AC05-84OR-21400)
(DE91-011255; ORNL/TM-11814) Avail: NTIS HC/MF A03

This paper presents a new left-looking parallel sparse Cholesky factorization algorithm for shared-memory MIMD multiprocessors. The algorithm is particularly well-suited for vector supercomputers with multiple processors, such as the Cray Y-MP. The new algorithm uses supernodes in the Cholesky factor to improve performance by reducing indirect addressing and memory traffic. Earlier factorization algorithms have also used supernodes in this manner. The new algorithm, however, also uses supernodes to reduce the number of system synchronization calls, often by an order of

magnitude or more in practice. Experimental results on a Sequent Balance 8000 and a Cray Y-MP demonstrate the effectiveness of the new algorithm. On eight processors of a Cray Y-MP, the new routine performs the factorization at rates exceeding one Gflop for several test problems from the Harwell Boeing test collection, none of which are exceedingly large by current standards. DOE

N91-25678# Department of Energy, Washington, DC.
THE DOE PROGRAM IN HIGH PERFORMANCE COMPUTING AND COMMUNICATIONS
Feb. 1991 43 p
(DE91-011515; DOE/ER-0489P) Avail: NTIS HC/MF A03

The Department of Energy (DOE) High Performance Computing and Communications (HPCC) program will emphasize research in each of four key areas. Selected computational challenges, which have a significant effect on national leadership in science and technology, will be used as focal points for these efforts. These areas are: HPCC systems -- evaluate advanced architectures for large-scale scientific and engineering applications; advanced software technology and algorithms -- research computational methods, algorithms, and tools; develop large-scale data-handling techniques; establish HPCC research centers; exploit extensive teaming among scientists and engineers, applied mathematicians, and computer scientists; national research and education network -- research and develop high-speed networking technologies; basic research and human resources -- encourage research partnerships between national laboratories, industry, and universities; support computational mathematics and computer science research; establish research and educational programs in computational science; enhance K through 12 education. This report discusses accomplishments in these areas. DOE

N91-25679# Ames Lab., IA.
SCALABILITY OF PARALLEL ALGORITHM-MACHINE COMBINATIONS
Xian-He Sun and D. T. Rover 1991 24 p
(Contract W-7405-eng-82)
(DE91-011902; IS-M-666) Avail: NTIS HC/MF A03

Scalability has become an important consideration in parallel algorithm and machine designs. The word scalable, or scalability, has been widely and oftenly used in the parallel processing community. However, there is no adequate, commonly accepted definition of scalability available. Scalabilities of computer systems and programs are difficult to quantify, evaluate, and compare. In this paper, scalability is formally defined for algorithm-machine combinations. A practical method is proposed to provide a quantitative measurement of the scalability. The relation between the newly proposed scalability and other existing parallel performance metrics is studied. A harmony between speedup and scalability has been observed. Theoretical results show that a large class of algorithm-machine combinations is scalable and the scalability can be predicted through premeasured machine parameters. Two case studies have been conducted on an nCUBE 2 multicomputer. The first case satisfies the conditions of our theoretical results. Its experimental results match the theoretical results well. The second case has a sophisticated structure and demands novel techniques for measuring and perceiving its performance. Performance instrumentation and visualization tools have been used and developed to understand the scalability related behavior. This visualization approach provides a unique way to reveal characteristics which correspond to the scalability of an algorithm-machine combination. DOE

N91-25680*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AN AUTONOMOUS FAULT DETECTION, ISOLATION, AND RECOVERY SYSTEM FOR A 20-kHz ELECTRIC POWER DISTRIBUTION TEST BED
Todd M. Quinn (Sverdrup Technology, Inc., Brook Park, OH.) and Jerry L. Walters Jun. 1991 18 p
(Contract NAS3-25266)
(NASA-TM-104344; E-6118; NAS 1.15:104344) Avail: NTIS HC/MF A03 CSCL 09B

Future space explorations will require long term human presence in space. Space environments that provide working and living quarters for manned missions are becoming increasingly larger and more sophisticated. Monitor and control of the space environment subsystems by expert system software, which emulate human reasoning processes, could maintain the health of the subsystems and help reduce the human workload. The autonomous power expert (APEX) system was developed to emulate a human expert's reasoning processes used to diagnose fault conditions in the domain of space power distribution. APEX is a fault detection, isolation, and recovery (FDIR) system, capable of autonomous monitoring and control of the power distribution system. APEX consists of a knowledge base, a data base, an inference engine, and various support and interface software. APEX provides the user with an easy-to-use interactive interface. When a fault is detected, APEX will inform the user of the detection. The user can direct APEX to isolate the probable cause of the fault. Once a fault has been isolated, the user can ask APEX to justify its fault isolation and to recommend actions to correct the fault. APEX implementation and capabilities are discussed. Author

N91-25681# Bhabha Atomic Research Centre, Bombay (India).
ISSUES IN DEVELOPING PARALLEL ITERATIVE ALGORITHMS FOR SOLVING PARTIAL DIFFERENTIAL EQUATIONS ON A (TRANSPUTER-BASED) DISTRIBUTED PARALLEL COMPUTING SYSTEM
S. Rajagopalan, A. Jethra, A. N. Khare, M. D. Ghodgaonkar, R. Srivenkateshan, and S. V. G. Menon 1990 29 p
(DE91-622927; BARC-1513) Avail: NTIS HC/MF A03

Issues relating to implementing iterative procedures, for numerical solution of elliptic partial differential equations, on a distributed parallel computing system are discussed. Preliminary investigations show that a speed-up of about 3.85 is achievable on a four transputer pipeline network. DOE

N91-25682*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
THE QDP/PLT USER'S GUIDE
Allyn F. Tennant Washington Jun. 1991 92 p
(NASA-TM-4301; M-662; NAS 1.15:4301) Avail: NTIS HC/MF A05 CSCL 09B

PLT is a high level plotting package. A Programmer can create a default plot suited for the data being displayed. At run times, users can then interact with the plot overriding any or all of these defaults. The user is also provided the capability to fit functions to the displayed data. This ability to display, interact with, and to fit the data make PLT a useful tool in the analysis of data. The Quick and Dandy Plotter (QDP) program will read ASCII text files that contain PLT commands and data. Thus, QDP provides and easy way to use the PLT software QPD files provide a convenient way to exchange data. The QPD/PLT software is written in standard FORTRAN 77 and has been ported to VAX VMS, SUN UNIX, IBM AIX, NeXT NextStep, and MS-DOS systems. Author

N91-25683*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
SEAPAK USER'S GUIDE, VERSION 2.0. VOLUME 1: SYSTEM DESCRIPTION
Charles R. McClain, Michael Darzi, James K. Firestone, Gary Fu, Eueng-nan Yeh (General Sciences Corp., Laurel, MD.), and Daniel L. Endres Washington Apr. 1991 150 p
(NASA-TM-100728-Vol-1; Rept-91B00090-Vol-1; NAS 1.15:100728-Vol-1) Avail: NTIS HC/MF A07 CSCL 09B

The SEAPAK is a user interactive satellite data analysis package that was developed for the processing and interpretation of Nimbus-7/Coastal Zone Color Scanner (CZCS) and the NOAA Advanced Very High Resolution Radiometer (AVHRR) data. Significant revisions were made to version 1.0 of the guide, and the ancillary environmental data analysis module was expanded. The package continues to emphasize user friendliness and user interactive data analyses. Additionally, because the scientific goals of the ocean color research being conducted have shifted to large space and time scales, batch processing capabilities for both

satellite and ancillary environmental data analyses were enhanced, thus allowing large quantities of data to be ingested and analyzed in background. Author

N91-25684*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
SEAPAK USER'S GUIDE, VERSION 2.0. VOLUME 2: DESCRIPTIONS OF PROGRAMS
Charles R. McClain, Michael Darzi, James K. Firestone, Gary Fu, Eueng-nan Yeh (General Sciences Corp., Laurel, MD.), and Daniel L. Endres Washington Apr. 1991 468 p
(NASA-TM-100728-Vol-2; Rept-91B00090-Vol-2; NAS 1.15:100728-Vol-2) Avail: NTIS HC/MF A20 CSCL 09B

The SEAPAK is a user-interactive satellite data analysis package that was developed for the processing and interpretation of Nimbus-7/Coastal Zone Color Scanner (CZCS) and the NOAA Advanced Very High Resolution Radiometer (AVHRR) data. Significant revisions were made since version 1.0, and the ancillary environmental data analysis module was greatly expanded. The package continues to be user friendly and user interactive. Also, because the scientific goals of the ocean color research being conducted have shifted to large space and time scales, batch processing capabilities for both satellite and ancillary environmental data analyses were enhanced, thus allowing for large quantities of data to be ingested and analyzed. Author

N91-25131# Royal Aircraft Establishment, Farnborough (England).
A METHODOLOGY FOR PRODUCING VALIDATED REAL-TIME EXPERT SYSTEMS
S. A. Cross and M. Grisoni (Logica Ltd., Cambridge, England) *In* AGARD, Knowledge Based System Applications for Guidance and Control Apr. 1991 11 p (For primary document see N91-25121 17-04)
Copyright Avail: NTIS HC/MF A12; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

N91-25134# Royal Aircraft Establishment, Farnborough (England).
AN Ada FRAMEWORK FOR THE INTEGRATION OF KBS AND CONTROL SYSTEM SIMULATIONS
M. J. Corbin and G. F. Butler *In* AGARD, Knowledge Based System Applications for Guidance and Control Apr. 1991 6 p (For primary document see N91-25121 17-04)
Copyright Avail: NTIS HC/MF A12; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

N91-25214*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
INTERDEPENDENT FIGURE-OF-MERIT SOFTWARE DEVELOPMENT
K. Ramohalli and T. Kirsch *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 4 p (For primary document see N91-25203•17-25)
Avail: NTIS HC/MF A08 CSCL 09B

N91-25458*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
NASA/AMES RESEARCH CENTER DC-8 DATA SYSTEM
S. C. Cherniss (Sterling Software, Moffett Field, CA.) and C. P. Scofield *In* NASA, Washington, 4th Airborne Geoscience Workshop 1991 p 127-130 (For primary document see N91-25445 17-42)
Avail: NTIS HC/MF A13 CSCL 09B

N91-25923*# Morgan State Univ., Baltimore, MD. Dept. of Electrical Engineering.
IMAGE DATA COMPRESSION INVESTIGATION Abstract Only
Carlos Myrie *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 20 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 09B

N91-25937*# Kansas Coll. of Technology, Salina. Dept. of Computer Science.
DETECTION AND AVOIDANCE OF ERRORS IN COMPUTER SOFTWARE
Les Kinsler *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 35 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 09B

62 COMPUTER SYSTEMS

Includes computer networks and special application computer systems.

N91-25685*# Softech, Inc., Houston, TX.
AdaNET KEY ISSUES SUMMARY REPORT
30 Apr. 1991 10 p Prepared in cooperation with Houston Univ., Clear Lake, TX Prepared for MountainNet, Inc., Dellslow, WV
(Contract NCC9-16; Proj. RICIS SE-18)
(NASA-CR-188241; NAS 1.26:188241; ADANET-FD-R/T-084-0)
Avail: NTIS HC/MF A02 CSCL 09B

The following subject areas are covered: selection of AutoLib for ASV3; ASV3 use of AutoLib; quality engineering and its implications for AdaNet; and lessons learned from related efforts. Author

N91-25686*# Softech, Inc., Houston, TX.
COOPERATIVE PROCESSING USER INTERFACES FOR AdaNET
Kurt M. Gutzmann 30 Apr. 1991 17 p Prepared in cooperation with Houston Univ., Clear Lake, TX Prepared for MountainNet, Inc., Dellslow, WV
(Contract NCC9-16; Proj. RICIS-SE-18)
(NASA-CR-188239; NAS 1.26:188239; ADANET-FD-R/T-085-0)
Avail: NTIS HC/MF A03 CSCL 09B

A cooperative processing user interface (CUI) system shares the task of graphical display generation and presentation between the user's computer and a remote host. The communications link between the two computers is typically a modem or Ethernet. The two main purposes of a CUI are reduction of the amount of data transmitted between user and host machines, and provision of a graphical user interface system to make the system easier to use. Author

N91-25687*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ANALYSIS OF THE INTEL 386 AND i486 MICROPROCESSORS FOR THE SPACE STATION FREEDOM DATA MANAGEMENT SYSTEM
Yuan-Kwei Liu May 1991 24 p
(NASA-TM-103862; A-91145; NAS 1.15:103862) Avail: NTIS HC/MF A03 CSCL 09B

The feasibility is analyzed of upgrading the Intel 386 microprocessor, which has been proposed as the baseline processor for the Space Station Freedom (SSF) Data Management System (DMS), to the more advanced i486 microprocessors. The items compared between the two processors include the instruction set architecture, power consumption, the MIL-STD-883C Class S (Space) qualification schedule, and performance. The advantages of the i486 over the 386 are (1) lower power consumption; and (2) higher floating point performance. The i486 on-chip cache does not have parity check or error detection and correction circuitry. The i486 with on-chip cache disabled, however, has lower integer performance than the 386 without cache, which is the current DMS design choice. Adding cache to the 386/386 DX memory hierachy appears to be the most beneficial change to the current DMS design at this time. Author

N91-25688# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
INTRODUCTION TO PROGRAM VERIFICATION

Krzysztof R. Apt and Ernst-Ruediger Olderog (Oldenburg Univ., Germany, F.R.) Aug. 1990 73 p Submitted for publication Sponsored by Netherlands Organization for the Advancement of Research
(CWI-CS-R9036; ETN-91-99366) Copyright Avail: NTIS HC/MF A04

A systematic introduction to program verification based on the assertional method is presented. Deterministic, nondeterministic, parallel and distributed programs are studied and properties such as partial correctness, termination, absence of failures, interference freedom and deadlock freedom are dealt with. ESA

N91-25689# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
COMPUTING BOOLEAN FUNCTIONS ON ANONYMOUS HYPERCUBE NETWORKS (EXTENDED ABSTRACT)
Evangelos Kranakis and Danny Krizanc (Rochester Univ., NY.) Aug. 1990 15 p Submitted for publication Sponsored by Netherlands Organization for the Advancement of Research
(CWI-CS-R9040; ETN-91-99370) Copyright Avail: NTIS HC/MF A03

The bit complexity (i.e., total number of bits transmitted) of computing boolean functions in anonymous oriented hypercubes is studied. The class of boolean functions computable in the anonymous oriented hypercube is characterized as exactly those boolean functions which are invariant under all bit complement automorphisms of the hypercube and an algorithm for computing all such functions with bit complexity O (N.log to the 4th power N) is provided. Thus among all studied oriented networks (rings, tori, etc.) the hypercube seems to achieve 'optimal' bit complexity for a given number of nodes. ESA

N91-25690# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.
BLOCK-CHOLESKY FOR PARALLEL PROCESSING
Magreet Louter-Nool Dec. 1990 23 p Submitted for publication Sponsored by Netherlands Organization for the Advancement of Research
(CWI-NM-R9023; ETN-91-99416) Copyright Avail: NTIS HC/MF A03

Cholesky factorization of A = L L(sup T), where A is a positive definite symmetric matrix and L is a lower triangular matrix, is addressed. A blocked algorithm based on level 3 BLAS is discussed. When using Level 3 BLAS kernels in a multiprocessing mode, one can parallelize within each kernel, or can obtain parallelism by performing different matrix-matrix operations on different processors. Parallelism over the blocks is applied. The amount of parallelism is studied and the data dependency graph is discussed. The SCHEDULE package is used to obtain a portable scheduling of the tasks. Numerical results of the method are presented and compared with the results for the block algorithm parellelized within the level 3 BLAS kernels. ESA

N91-25691# Texas Univ., Austin.
PARALLEL SUPERCOMPUTING: ADVANCED METHODS, ALGORITHMS, AND SOFTWARE FOR LARGE-SCALE PROBLEMS
G. F. Carey and D. M. Young Apr. 1991 9 p
(Contract DE-FG05-87ER-25048)
(DE91-011430; DOE/ER-25048/3) Avail: NTIS HC/MF A02

This report briefly discusses the iterative techniques and algorithms developed for parallel processors at the University of Texas. DOE

N91-25692# Argonne National Lab., IL.
EXPLOITING PARALLELISM IN AUTOMATIC DIFFERENTIATION
C. Bischof, A. Griewank, and D. Juedes 1991 14 p Presented at the 5th International Association for Computing Machinery Conference on Supercomputing, Cologne (Fed. Republic of Germany), 17-21 Jun. 1991
(Contract W-31-109-eng-38)
(DE91-011841; ANL/CP-72304; CONF-9106163-1) Avail: NTIS HC/MF A03

The numerical methods employed in the solution of many scientific computing problems require the computation of first or second order derivatives of a function f:R(sup n) yields R(sup m). We present an approach that, given a serial C program for the computation of f(x), derives a parallel execution schedule for the computation of f and its derivatives in a completely automatic fashion. This is achieved by overloading the computation of f(x) in C++ to obtain a trace of the computations to be performed and then transforming this trace into a data flow graph for the computation of f(x). In addition to the computation f(x), this graph also allows us to exactly and inexpensively compute derivates of f by the repeated use of the chain rule. Parallelism is exploited in two ways: rows or columns of derivative matrices can be computed by independent passes through the computational graph, and parallelism within the processing of this computational graph can be exploited by processing independent subgraphs concurrently. We present experimental results that show that good performance on shared-memory machines can be obtained by using a graph interpreter approach. We then present some ideas that are currently under development for regulating computational granularity, and to allow for the derivation of a compiled program for the parallel computation of f and its derivatives, using the parallel composition notation (PCN) parallel language environment. DOE

N91-25693*# National Aeronautics and Space Administration. Pasadena Office, CA.
DYNAMIC RESOURCE ALLOCATION SCHEME FOR DISTRIBUTED HETEROGENEOUS COMPUTER SYSTEMS Patent
Howard T. Liu, inventor (to NASA) and John A. Silvester, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 9 Jul. 1991 12 p Filed 30 Dec. 1988 Supersedes N89-29978 (27 - 24, p 3493)
(Contract NAS7-918)
(NASA-Case-NPO-17197-1-CU; US-Patent-5,031,089; US-Patent-Appl-SN-292124; US-Patent-Class-364-200; US-Patent-Class-364-281.3; US-Patent-Class-364-281; US-Patent-Class-364-281.6; US-Patent-Class-364-281.8; Int-Patent-Class-G06F-12/00) Avail: US Patent and Trademark Office CSCL 09B

This invention relates to a resource allocation in computer systems, and more particularly, to a method and associated apparatus for shortening response time and improving efficiency of a heterogeneous distributed networked computer system by reallocating the jobs queued up for busy nodes to idle, or less-busy nodes. In accordance with the algorithm (SIDA for short), the load-sharing is initiated by the server device in a manner such that extra overhead in not imposed on the system during heavily-loaded conditions. The algorithm employed in the present invention uses a dual-mode, server-initiated approach. Jobs are transferred from heavily burdened nodes (i.e., over a high threshold limit) to low burdened nodes at the initiation of the receiving node when: (1) a job finishes at a node which is burdened below a pre-established threshold level, or (2) a node is idle for a period of time as established by a wakeup timer at the node. The invention uses a combination of the local queue length and the local service rate ratio at each node as the workload indicator.
Official Gazette of the U.S. Patent and Trademark Office

N91-25934*# Towson State Univ., MD. Dept. of Computer and Information Sciences.
COMPUTER NETWORK ENVIRONMENT PLANNING AND ANALYSIS Abstract Only
John F. Dalphin *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 32 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 09B

N91-25941*# Bowie State Univ., MD. Dept. of Computer Science.
DATA SYSTEM INTERPROBABILITY Abstract Only
Nagi T. Wakim *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 39 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 09B

63 CYBERNETICS

Includes feedback and control theory, artificial intelligence, robotics and expert systems.

For related information see also *54 Man/System Technology and Life Support.*

N91-25694 Virginia Polytechnic Inst. and State Univ., Blacksburg.
OPTIMAL CONTROL PROBLEMS WITH SWITCHING POINTS Ph.D. Thesis
Hans Seywald 1990 243 p
Avail: Univ. Microfilms Order No. DA9109418

An overview of the problems and difficulties that arise in solving optimal control problems with switching points is presented. A brief discussion of existing optimality conditions and a numerical approach for solving the multipoint boundary value problems associated with the first-order necessary conditions of optimal control are also presented. Two real-life aerospace optimization problems are treated explicitly. These are attitude maximization for a sounding rocket (Goddard problem) in presence of a dynamic pressure limit, and range maximization of a supersonic aircraft flying in the vertical plane, also in presence of a dynamic pressure limit. In the second problem, singular control appears along arcs with active dynamic pressure limit, which, in the context of optimal control, represents a first-order state inequality constraint. An extension of the generalized Legendre-Clebsch condition to the case of singular control along state/control constrained arcs is presented and is applied to the aircraft range maximization problem stated above. A contribution to the field of Jacobi necessary conditions is made by giving a new proof for the non-optimality of conjugate paths in the accessory minimum problem. Because of its simple and explicit character the new proof may provide the basis for an extension of Jacobi's necessary condition to the case of trajectories with interior point constraints. Finally, the result that touch points cannot occur for first-order state inequality constraints is extended to the case of vector valued control functions.
Dissert. Abstr.

N91-25695 Stanford Univ., CA.
RECURSIVE DERIVATION OF EXPLICIT EQUATIONS OF MOTION FOR EFFICIENT DYNAMIC/CONTROL SIMULATION OF LARGE MULTIBODY SYSTEMS Ph.D. Thesis
Kurt Scott Anderson 1990 168 p
Avail: Univ. Microfilms Order No. DA9108778

The demands of spacecraft, robot, and machinery design have motivated the development of general purpose multibody computer programs for dynamic analysis. Such programs enable the analyst to simulate, with minimal manual effort, motions of large systems of rigid bodies, or to calculate the control forces and torques which must be applied to obtain a desired motion of such systems. Multibody programs tend to be plagued by two basic inefficiencies. The first, and most severe, arises from computational requirements associated with the determination of state derivative values. If n is the number of degrees of freedom of a system, the number of computational operations required to calculate state derivative values tends to be a cubic function in n, and thus can become prohibitively large for even modest values of n. The second inefficiency manifests itself when equations are derived for the most general system, as they frequently are. Such implicit programs generally are replete with unnecessary computations or logical statements. Presented here is an approach which does not suffer from either of these deficiencies. State derivative values are calculated in a highly efficient manner, the number of computational operations being a linear function in n. Problem specific equations are generated through the use of symbolic manipulation, which yields explicit equations devoid of needless operations. Finally, the equations are cast in a highly concurrent form, allowing the production of a simulation code that can be used on conventional sequential computers, but is well suited for parallel computers with distributed architecture.
Dissert. Abstr.

N91-25696*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A DISTRIBUTED FAULT-DETECTION AND DIAGNOSIS SYSTEM USING ON-LINE PARAMETER ESTIMATION
T.-H. Guo, W. Merrill, and A. Duyar (Florida Atlantic Univ., Boca Raton.) 1991 8 p Presented at the International Symposium on Distributed Intelligence Systems, Arlington, VA, 13-15 Aug. 1991; sponsored by the International Federation of Automatic Control Technical Committee on Systems Engineering
(NASA-TM-104433; E-6271; NAS 1.15:104433) Avail: NTIS HC/MF A02 CSCL 09B

The development of a model-based fault-detection and diagnosis system (FDD) is reviewed. The system can be used as an integral part of an intelligent control system. It determines the faults of a system from comparison of the measurements of the system with a priori information represented by the model of the system. The method of modeling a complex system is described and a description of diagnosis models which include process faults is presented. There are three distinct classes of fault modes covered by the system performance model equation: actuator faults, sensor faults, and performance degradation. A system equation for a complete model that describes all three classes of faults is given. The strategy for detecting the fault and estimating the fault parameters using a distributed on-line parameter identification scheme is presented. A two-step approach is proposed. The first step is composed of a group of hypothesis testing modules, (HTM) in parallel processing to test each class of faults. The second step is the fault diagnosis module which checks all the information obtained from the HTM level, isolates the fault, and determines its magnitude. The proposed FDD system was demonstrated by applying it to detect actuator and sensor faults added to a simulation of the Space Shuttle Main Engine. The simulation results show that the proposed FDD system can adequately detect the faults and estimate their magnitudes.
L.K.S.

N91-25697# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
MODELING DESIGN PROCESSES
Hideaki Takeda, Tetsuo Tomiyama, Hiroyuki Yoshikawa (Tokyo Univ., Japan), and Paul J. Veerkamp Oct. 1990 28 p Sponsored by Netherlands Organization for the Advancement of Research
(CWI-CS-R9059; ETN-91-99389) Copyright Avail: NTIS HC/MF A03

A discussion which aims at building a computable design process model which is a prerequisite for realizing intelligent CAD (Computer Aided Design) systems is presented. Design processes are discussed from a theoretical point of view; general design theory, from which a descriptive model of design processes is derived, is introduced. In this model, the concept of metamodels plays a crucial role to describe the evolutionary nature of design. Design processes are examined from a cognitive viewpoint. A cognitive design process model obtained by observing design processes using a protocol analysis method is shown. A computable model that can explain most parts of the cognitive model and that also can interpret the descriptive model is discussed. In the computable model, a design process is regarded as an iterative logical process realized by abduction, deduction, and circumscription. A design simulator that can trace design processes in which design specifications and design solutions are progressively revised as the design proceeds is implemented.
ESA

N91-25698# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
A COMPONENT CLASS FOR DESIGN OBJECTS

Jan L. H. Rogier (Netherlands Organization for Applied Scientific Research TNO, Delft.) Oct. 1990 22 p Sponsored by Netherlands Organization for the Advancement of Research
(CWI-CS-R9060; ETN-91-99390) Copyright Avail: NTIS HC/MF A03

An architectural design support system based on a strategy of incremental spatial decomposition of a design object is discussed. It provides mechanisms for the application knowledge. Two basic strategies used in architectural design, decomposition and application of prototypes is discussed. By means of an example, it is shown how the system actually supports an architectural design process and how the system is used to communicate with external, autonomous design support expert systems. Such systems provide special facilities for drawing, calculating and other tasks performed during a design process, and are interfaced by means of the design system. An evaluation of the work is given and topics for further research for the project (the IIICAD, Intelligent Integrated Interactive Computer Aided Design project) are proposed. The aim of system is to provide a sound basis for the tools developed in the IIICAD project and at the same time to be an interface to already existing tools like expert systems for finite element method, modelers, drawing machines etc. ESA

N91-25699# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
REPRESENTATION AND IMPLEMENTATION OF DESIGN KNOWLEDGE FOR INTELLIGENT CAD: THEORETICAL ASPECTS
Paul J. Veerkamp, Takashi Kiriyama, Deyi Xue, and Tetsuo Tomiyama (Tokyo Univ., Japan) Dec. 1990 19 p Sponsored by Netherlands Organization for the Advancement of Research
(CWI-CS-R9070; ETN-91-99400) Copyright Avail: NTIS HC/MF A03

Theoretical aspects of design knowledge representation and its implementation are addressed. A design process is described as step wise refinement along three design stages, i.e., conceptual, fundamental, and detailed design. As a general model of design activities in these design stages, metamodel is proposed. Based on the model, design knowledge representation is discussed. Since a design object is constrained by the physical laws of the real world, knowledge about a physical world, i.e., ontological knowledge, is indispensable to design a new artifact. Metamodel mechanism, which allows an ICAD (Intelligent Computer Aided Design) system to support a designer with ontological knowledge is presented. A physical feature library is proposed as a knowledge base of physical phenomena. ESA

N91-25700# Technical Research Centre of Finland, Espoo. Lab. for Information Processing.
CONSTRAINT REASONING WITH INCOMPLETE KNOWLEDGE: THE TOLERANCE PROPAGATION APPROACH Ph.D. Thesis - Helsinki Univ. of Technology
Eero Hyvoenen Jan. 1991 173 p Sponsored by Technology Development Center, DEC; Finnish PTT; Nokia Research Center; VTKK; Waertsilae Marine; Science and Technology Agency; Finnish Cultural Foundation
(VTT-72; ISBN-951-38-3928-1; ISSN-0358-5069; ETN-91-99505) Copyright Avail: NTIS HC/MF A08

Representational and computational problems arising in the Constraint Satisfaction Problem (CSP) formulation used in artificial intelligence, where the variables related by the constraints may be initially unknown within their domains but are assumed to have some exact value in each solution, are addressed. It is argued that the problem can be solved by generalizing the CSP formulation into what is called tolerance constraint satisfaction problem. A new reasoning scheme for solving the tolerance CSP, Tolerance Propagation (TP), is designed and implemented. The idea of the tolerance approach is to aim at and reason with solutions and value assignments in which variables refer to sets and intervals, i.e., to tolerances, instead of exact values. This makes it possible to represent and reason with incomplete and partly inconsistent knowledge in a well defined way. Application of the scheme to propositional logics leads into logical tolerance (constraint) systems that can be used to produce more intuitive results than ordinary two, multiple, or multivalued logics when dealing with incomplete knowledge. Applications of tolerance systems include numerical equation solving, consistency maintenace systems, support for mixed initiative consultation mode in expert systems, and support for stepwise refinement in problem solving. ESA

N91-25701# Argonne National Lab., IL.
OPTIMIZATION APPROACHES TO NONLINEAR MODEL PREDICTIVE CONTROL
L. T. Biegler and J. B. Rawlings (Texas Univ., Austin.) 1991 30 p
(Contract W-31-109-eng-38)
(DE91-011178; ANL/CP-72735) Avail: NTIS HC/MF A03

With the development of sophisticated methods for nonlinear programming and powerful computer hardware, it now becomes useful and efficient to formulate and solve nonlinear process control problems through on-line optimization methods. This paper explores and reviews control techniques based on repeated solution of nonlinear programming (NLP) problems. Here several advantages present themselves. These include minimization of readily quantifiable objectives, coordinated and accurate handling of process nonlinearities and interactions, and systematic ways of dealing with process constraints. We motivate this NLP-based approach with small nonlinear examples and present a basic algorithm for optimization-based process control. As can be seen this approach is a straightforward extension of popular model-predictive controllers (MPCs) that are used for linear systems. The statement of the basic algorithm raises a number of questions regarding stability and robustness of the method, efficiency of the control calculations, incorporation of feedback into the controller and reliable ways of handling process constraints. Each of these will be treated through analysis and/or modification of the basic algorithm. To highlight and support this discussion, several examples are presented and key results are examined and further developed. DOE

N91-25702# Sandia National Labs., Albuquerque, NM.
GENERIC COMMAND INTERPRETER FOR ROBOT CONTROLLERS
J. Werner Apr. 1991 6 p Presented at the 1991 Society of Women Engineers National Convention, San Diego, 23-29 Jun. 1991
(Contract DE-AC04-76DP-00789)
(DE91-011231; SAND-90-2515C; CONF-9106177-1) Avail: NTIS HC/MF A02

Generic command interpreter programs were written for robot controllers. Each interpreter program resides on a robot controller and interfaces the controller with a supervisory program on another (host) computer. These interpreter programs are called monitors because they wait, monitoring a communication line, for commands from the supervisory program. These monitors are designed to interface with the object-oriented software structure of the supervisory programs. The functions of the monitor programs are written in each robot controller's native language but reflect the object-oriented functions of the supervisory programs. These functions and other specifics of the monitor programs written for three different robots are discussed. DOE

N91-25122# Lockheed Aeronautical Systems Co., Thousand Oaks, CA.
THE PILOT'S ASSOCIATE: EXPLOITING THE INTELLIGENT ADVANTAGE
Douglas I. Holmes and John P. Retelle, Jr. (Lockheed Missiles and Space Co., Calabasas, CA.) *In* AGARD, Knowledge Based System Applications for Guidance and Control Apr. 1991 8 p
(For primary document see N91-25121 17-04)
Copyright Avail: NTIS HC/MF A12; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

N91-25132# Instituto Nacional de Tecnica Aeroespacial, Madrid (Spain).
A REVIEW OF SOME ASPECTS ON DESIGNING FUZZY CONTROLLERS
E. Trillas, M. Delgado, J. L. Verdegay, and M. A. Vila (Granada Univ., Spain) *In* AGARD, Knowledge Based System Applications for Guidance and Control Apr. 1991 12 p (For primary document see N91-25121 17-04)
Copyright Avail: NTIS HC/MF A12; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

N91-25133# Vanderbilt Univ., Nashville, TN.
A NEURAL NETWORK FOR THE ANALYSIS OF AIRCRAFT TEST DATA
J. B. Golden and B. A. Whitehead (Tennessee Univ. Space Inst., Tullahoma.) *In* AGARD, Knowledge Based System Applications for Guidance and Control Apr. 1991 13 p (For primary document see N91-25121 17-04)
Copyright Avail: NTIS HC/MF A12; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

N91-25906# Copenhagen Univ. (Denmark).
FIELDS OF APPLICATION OF THE PROCESSING OF NATURAL LANGUAGES WITH THE HELP OF ARTIFICIAL INTELLIGENCE
Bente Maegaard *In* AGARD, Bridging the Communication Gap Feb. 1991 5 p (For primary document see N91-25902 17-82)
Copyright Avail: NTIS HC/MF A06; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

64 NUMERICAL ANALYSIS

Includes iteration, difference equations, and numerical approximation.

N91-25703 Cincinnati Univ., OH.
FAULT-TOLERANT CONTROL OF CONTINUOUS-TIME SYSTEMS Ph.D. Thesis
Srichander Ramaswamy 1990 122 p
Avail: Univ. Microfilms Order No. DA9108584

The synthesis of a fault tolerant control law for linear systems that takes into account the random decision errors and delays associated with the failure detection scheme is presented. Under these conditions, when the control gains are reconfigured in response to the failure indications, the stability analysis of the resulting closed loop system that is governed by stochastic differential equations is addressed. This analysis makes use of stochastic Lyapunov functions and supermartingale theorems. Both exponential stability in the mean square and almost sure asymptotic stability in probability of all sample solutions of the given system are addressed. In particular, for linear systems, when the coefficients of the closed loop system dynamics are functions of two random processes with Markovian transition characteristics, necessary and sufficient conditions for exponential stability in the mean square of the solution are developed. Extension of these results to cases where one of the random processes has semi-Markovian transition characteristics is also investigated.
Author

N91-25704*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
DOMAIN DECOMPOSITION WITH LOCAL MESH REFINEMENT Final Report
William D. Gropp and David E. Keyes (Yale Univ., New Haven, CT.) Feb. 1991 33 p Previously announced as N90-18175 Submitted for publication
(Contracts NAS1-18605; W-31-109-eng-38; N00014-86-K-0310; NSF DCR-85-21451; NSF EET-87-07109; NSF ECS-89-57475) (NASA-CR-187528; NAS 1.26:187528; ICASE-IR-91-19) Avail: NTIS HC/MF A03 CSCL 12A

A preconditioned Krylov iterative algorithm is described based on domain decomposition for linear systems arising from implicit finite-difference or finite-element discretizations of partial differential equation problems requiring local mesh refinement. To keep data structures as simple as possible for parallel computing applications, the fundamental computational unit in the algorithm was defined as a subregion of the domain spanned by a locally uniform tensor-product grid, called tile. In the tile-based domain decomposition approach, two levels of discretization are considered at each point of the domain: a global coarse grid defined by tile vertices only, and a local fine grid where the degree of resolution can vary from tile to tile. One global level and one local level provide the flexibility required to adaptively discretize a diverse collection of problems on irregular regions and solve them at convergence rates that deteriorate only logarithmically in the finest mesh parameter, with the coarse tessellation held fixed. A logarithmic departure from optimality seems to be a reasonable compromise for the simplicity of the composite grid data structure and concomitant regular data exchange patterns in a multiprocessor environment. Some experiments with up to 1024 tiles are reported, the evolution of the algorithm is commented on, and it is contrasted with optimal nonrefining two-level algorithms and optimal refining multilevel algorithms. Computational comparisons with some other popular methods are presented.
Author

N91-25705# Joint Publications Research Service, Arlington, VA.
JPRS REPORT: SCIENCE AND TECHNOLOGY. CHINA: FUZZY LOGIC AND NEURAL NETWORKS
27 Feb. 1991 29 p Transl. into ENGLISH from conference held in Fukuoka, Japan, 22-24 Jul. 1990 p 155-158, 199-202, 267-281, and 325-328 International Conference on Fuzzy Logic and Neural Networks (IIZUKA 90) held in Fukuoka, Japan, 22-24 Jul. 1990; sponsored by the Kyushu Inst. of Tech.
(JPRS-CST-91-005) Avail: NTIS HC/MF A03

Abstracts of Chinese literature in various areas of fuzzy logic and neural networks are compiled. The following subject areas are covered: CMOS fuzzy logic circuits in current-mode toward large scale integration; an application of quantum theory to neural networks; the truth-valued flow inference networks; and neural network for ship recognition. For individual titles, see N91-25706 through N91-25708.

N91-25706# Joint Publications Research Service, Arlington, VA.
CMOS FUZZY LOGIC CIRCUITS IN CURRENT-MODE TOWARD LARGE SCALE INTEGRATION
Li Zhijian and Jiang Hong *In its* JPRS Report: Science and Technology. China: Fuzzy Logic and Neutral Networks 27 Feb. 1991 p 1-4 Transl. into ENGLISH from conference held in Fukuoka, Japan, 22-24 Jul. 1990 p 199-202 (For primary document see N91-25705 17-64)
Avail: NTIS HC/MF A03

CMOS current-mode circuit units are designed and fabricated completing various fuzzy logic operations and relevant processing. Experimental results show that these basic circuits have the advantage of simple structure, high functional density and high speed. They can be used as building blocks to achieve VLSI implementation of fuzzy hardwares. By the use of these circuit units a high speed fuzzy logic microprocessor for a real-time hardware expert system was designed.
Author

N91-25707# Joint Publications Research Service, Arlington, VA.
AN APPLICATION OF QUANTUM THEORY TO NEURAL NETWORK
Yu Shao-Bo, Hu Shou-Ren, and Van Jun-Yong *In its* JPRS Report: Science and Technology. China: Fuzzy Logic and Neutral Networks 27 Feb. 1991 p 5-8 Transl. into ENGLISH from conference held in Fukuoka, Japan, 22-24 Jul. 1990 p 267-281 (For primary document see N91-25705 17-64)
Avail: NTIS HC/MF A03

Back propagation rule was shown to be an efficient learning algorithm for multilayered neural networks. However, it is limited because it only finds local minima. Boltzmann machine was also shown to be an efficient learning rule. But it is limited because its learning rate is too slow. A quantum learning algorithm is proposed and simulated for multilayered neural networks. It is shown that

its learning rate is more rapid than that of Boltzmann machine, and it can find the global minimum unlike back propagation algorithm does. Author

N91-25708# Joint Publications Research Service, Arlington, VA.
THE TRUTH-VALUED FLOW INFERENCE NETWORK
Wang Pei Zhuang, Wu Zhi Qiao, and Teh Hoon Heng *In its* JPRS Report: Science and Technology. China: Fuzzy Logic and Neutral Networks 27 Feb. 1991 p 9-23 Transl. into ENGLISH from conference held in Fukuoka, Japan, 22-24 Jul. 1990 p 325-328 (For primary document see N91-25705 17-64)
Avail: NTIS HC/MF A03

The conventional fuzzy inference uses the fuzzy relation and the compositional rule of inference method. But there is a limitation for the fuzzy relation to represent complex knowledge and complicated control rules in fuzzy control systems. A new fuzzy inference method was proposed as an alternative namely Truth-valued Flow Inference method. By this method a proposition is regarded as a channel along which the truths can flow and the fuzzy inference is realized as such a process that the truth values flow along an inference channel from the top (precedence) and the end (antecedence). The truth value may decrease when flowing along the channel because there exists resistance in the channel. The concept of neural logic network was used to construct a Truth-Valued Flow Inference Network (TVFIN), extending the truth-valued flow inference to a neural network form. By the TVFIN it is flexible to represent knowledge and control rules in fuzzy control and carry out the fuzzy inference effectively. Author

N91-25709# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Analysis, Algebra and Geometry.
ADJOINTS OF SEMIGROUPS ACTING ON VECTOR-VALUED FUNCTION SPACES
G. Greiner (Tuebingen Univ., Germany, F.R.) and J. M. A. M. vanNeerven Sep. 1990 25 p Sponsored by Netherlands Organization for the Advancement of Research
(CWI-AM-R9018; ETN-91-99344) Copyright Avail: NTIS HC/MF A03

Representations of the sun-dual corresponding to a given translation group are given. A duality theorem for semigroups of a given form on tensor products of Banach spaces is developed. Under appropriate compactness assumptions, depending on the kind of tensor product taken, the sun-dual is shown. Results are applied to determine the sun-duals for semigroups induced on spaces of vector valued functions. ESA

N91-25710# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Analysis, Algebra and Geometry.
GRAPH MORPHOLOGY
H. J. A. M. Heijmans, P. Nacken, A. Toet, and L. Vincent (Harvard Univ., Cambridge, MA.) Oct. 1990 30 p Sponsored by Netherlands Foundation for Computer Science and Netherlands Organization for Scientific Research
(CWI-AM-R9019; ETN-91-99345) Copyright Avail: NTIS HC/MF A03

A systematic theory for the construction of morphological operators on graphs is presented. Graph morphology extracts structural information from graphs using predefined test probes called structuring graphs. Structuring graphs have a simple structure and are relatively small compared to the graph that is to be transformed. A neighborhood function on the set of vertices of a graph is constructed by relating individual vertices to each other whenever they belong to a local instantiation of the structuring graph. This function is used to construct dilations and erosions. The concept of structuring graph is also used to define openings and closings. The resulting morphological operators are invariant under symmetries of the graph. Graph morphology resembles classical morphology (which uses structuring elements to obtain translation invariant operators) to a large extent. However, not all results from classical morphology have analogs in graph morphology because the local graph structure may be different at different vertices. ESA

N91-25711# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Analysis, Algebra and Geometry.
COMPLEX LIE SEMIGROUPS, HARDY SPACES, AND THE GELFAND-GINDIKIN PROGRAM
G. I. Olshanskii (Academy of Sciences, USSR, Moscow) Oct. 1990 16 p Sponsored by Netherlands Organization for the Advancement of Research
(CWI-AM-R9020; ETN-91-99346) Copyright Avail: NTIS HC/MF A03

A study on Hardy type spaces on certain open submanifolds of complex groups is presented. The idea for the study came from a program by Gelfand and Gindikin for a harmonic analysis on semisimple Lie groups and pseudo Riemannian symmetric spaces. Analogs of Hardy spaces on semigroups are constructed and their properties are studied. ESA

N91-25712# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Analysis, Algebra and Geometry.
TWISTED YANGIANS AND INFINITE-DIMENSIONAL CLASSICAL LIE ALGEBRAS
G. I. Olshanskii (Academy of Sciences, USSR, Moscow) Oct. 1990 25 p Sponsored by Netherlands Organization for the Advancement of Research
(CWI-AM-R9021; ETN-91-99347) Copyright Avail: NTIS HC/MF A03

The Yangians are quantized enveloping algebras of polynomial current Lie algebras and twisted Yangians should be their analogs for twisted polynomial current Lie algebras. Certain examples of twisted Yangians are defined and their relationship to a problem which arises in representation theory of infinite dimensional classical groups is described. ESA

N91-25713# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Analysis, Algebra and Geometry.
A PROOF OF THE RELATIVIZED, NON-METRIC FORM OF FURSTENBERG'S STRUCTURE THEOREM
Jan deVries Oct. 1990 9 p Sponsored by Netherlands Organization for the Advancement of Research
(CWI-AM-R9022; ETN-91-99348) Copyright Avail: NTIS HC/MF A02

A rather direct proof of the result mentioned in the title is presented. It combines methods of McMahon, McMahon and Wu, Glasner and Furstenberg. No use is made of auxiliary topologies (tau topologies, or Furstenberg topologies), but instead the notion of a relatively invariant measure plays a central role. ESA

N91-25714# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
ON THE RANDOM WALK WITH ZERO DRIFTS IN THE FIRST QUADRANT OF R2
J. W. Cohen Jul. 1990 14 p Sponsored by Netherlands Organization for the Advancement of Research
(CWI-BS-R9022; ETN-91-99351) Copyright Avail: NTIS HC/MF A03

The random walk on the lattice in the positive quadrant is studied for the case that the one step displacement vector has zero drift, finite second moments and support contained in the set whose members are -1, 0, 1, 0 and so on by the set -1, 0, 1, 2 and so on. It is well known that the first entrance time out from a point in the interior of the lattice into union of the coordinate axes is finite probability one. It is shown that its first moment is finite if and only if the covariance of the x and y component of the one step displacement vector is negative. For this case explicit expressions are given for the first moment of the entrance time and for the first and second moments of the hitting point of the

axes, in terms of the second moment characteristics of the one step displacement vector. The results are deduced from the hitting point identity for the random walk. ESA

N91-25715# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
A CONSTRAINED OPTIMISATION PROBLEM IN A PROCESSOR SHARING QUEUE
Peter R. deWaal Sep. 1990 28 p Sponsored by Netherlands Organization for the Advancement of Research
(CWI-BS-R9025; ETN-91-99354) Copyright Avail: NTIS HC/MF A03

A processor sharing queueing model for a stored program controlled telephone exchange is discussed. The model incorporates the effects of both call requests and operator tasks on the load of the processor. Newly arriving call requests and operator tasks can either be admitted or rejected and for this decision the state of the queue at the moment of arrival is available as information. To guarantee a high level of service, a constraint optimization problem is developed. Two types of access control, partitioning policies and sharing policies, are considered. The optimization problem is solved for partitioning policies and the performance of both types of policies are compared. ESA

N91-25716# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
ON TUTTE'S CHARACTERIZATION OF GRAPHIC MATROIDS: A GRAPHIC PROOF
A. M. H. Gerards Oct. 1990 11 p Sponsored by Netherlands Organization for the Advancement of Research
(CWI-BS-R9028; ETN-91-99357) Copyright Avail: NTIS HC/MF A03

A relatively simple proof of Tutte's characterization of graphic matroids is presented. The proof uses the notion of 'signed graph' and it is 'graphic' in the sense that it can be presented almost entirely by drawing (signed) graphs. ESA

N91-25717# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
REALIZATION AND PARTIAL FRACTIONS
M. Kuijper and J. M. Schumacher (Tilburg Univ., Netherlands) Oct. 1990 18 p Submitted for publication Sponsored by Netherlands Organization for the Advancement of Research
(CWI-BS-R9032; ETN-91-99361) Copyright Avail: NTIS HC/MF A03

The relation between two intrinsically different proposals that have been made in the literature concerning the representation by constant matrices of rational matrices given in fractional form is discussed. The relation turns out to be most naturally studied in the framework of partial fraction decompositions. The realization theory for decomposition is developed with respect to arbitrary complementary parts of the extended complex plane which may, for instance, correspond to stability and instability. An isomorphism is obtained which connects the spaces used in the two methods, and several identities relating to the McMillan degree are derived in a direct way. A new computational procedure is given to obtain the partial fraction decomposition of a relational matrix given in fractional form. ESA

N91-25718# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
NEAR-PERFECT MATRICES
F. B. Shepherd Dec. 1990 29 p Sponsored by Netherlands Organization for the Advancement of Research
(RWI-BS-R9034; ETN-91-99362) Copyright Avail: NTIS HC/MF A03

A 0,1 matrix A is near perfect if the integer hull of the polyhedron the set whose members are x greater than or equal to 0: Ax less than or equal to 1 bar, can be obtained by adding one extra (rank) constraint. Such matrices are shown to generally arise as the clique node incidence matrices of graphs. A colouring (that is, non polyhedral) characterization of the corresponding class of near perfect graphs is given and the following conjecture is made: a graph is near perfect if and only if sequentially lifting any rank inequality associated with a minimally imperfect graph results in the rank inequality for the whole graph. The conjecture is shown to be implied by the strong perfect graph conjecture. It is also shown to hold for small graphs (no stable set of size eleven). The results are used to strengthen (and give a new proof of) a theorem of Padberg and give a new characterization of minimally imperfect graphs: a graph is minimally imperfect if and only if both it and its complement are near perfect. ESA

N91-25719# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
THE GAMMA-NEIGHBORHOOD GRAPH
Remco C. Veltkamp (Leiden Univ., Netherlands) Jul. 1990 24 p Sponsored by Netherlands Organization for the Advancement of Research
(CWI-CS-R9034; ETN-91-99365) Copyright Avail: NTIS HC/MF A03

A two parameter geometric graph, the gamma neighborhood graph, is presented. This graph unifies a number of geometric graphs such as the convex hull, the Delaunay triangulation, and in two dimensions also the Gabriel graph, and the circle based beta skeleton, into a continuous spectrum of geometric graphs that ranges from the void, to the complete graph. The two parameters provide for a great flexibility in the analysis of a set of sites. For specific ranges of the parameters, the corresponding graph can be efficiently constructed. ESA

N91-25720# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
TRANSFINITE REDUCTIONS IN ORTHOGONAL TERM REWRITING SYSTEMS
J. R. Kennaway, Jan Willem Klop, M. R. Sleep (East Anglia Univ., Norwich, England), and F. J. deVries Dec. 1990 51 p Sponsored in part by Commission of the European Communities (Grant SERC-GR/F-91582)
(CWI-CS-R9041; ETN-91-99371) Copyright Avail: NTIS HC/MF A04

Some fundamental facts in the theory of infinitary Orthogonal Term Rewriting Systems (OTRSs) are established: for strongly convergent reductions, the infinitary parallel moves lemma and the compression lemma are proved. The infinite Church-Rosser property is addressed. Head normal form, Boehm reduction and Boehm tree from lambda-calculus to term rewriting are generalized. For OTRSs, any term has a unique Boehm tree, and Boehm reduction satisfies the infinite Church-Rosser property. Results concerning needed redexes from finitary orthogonal rewriting carry over to the infinite setting by adding fairness considerations: needed-fair reductions are normalizing, parallel. Outermost reduction is transfinitely hypernormalizing and depth increasing reduction is hypernormalizing. The relation between graph rewriting allows cyclic graphs as well. Sekar and Ramakrishnan's notion of necessary sets is useful to handle needed redexes in a graph: needed redexes in a graph correspond to necessary sets of redexes in the unraveling of the graph. It follows that the strongly sequential orthogonal term graph rewrite systems an effective normalizing strategy exists. Graph rewrite systems are tree-reducible and OTRSs are graph-reducible. ESA

N91-25721# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
TRANSFINITE REDUCTIONS IN ORTHOGONAL TERM REWRITING SYSTEMS (EXTENDED ABSTRACT)
J. R. Kennaway, Jan Willem Klop, M. R. Sleep (East Anglia Univ., Norwich, England), and F. J. deVries Sep. 1990 19 p Sponsored by Commission of the European Communities and Netherlands Organization for the Advancement of Research
(CWI-CS-R9042; ETN-91-99372) Copyright Avail: NTIS HC/MF A03

Some fundamental facts for infinitary Orthogonal Term Rewriting Systems (ORTSs) are established. For strongly convergent reductions the transfinite parallel moves lemma and the compressing lemma are proved. Strongness is necessary as shown by counterexamples. Normal forms (which are allowed to be infinite) are unique, in contrast to omega normal forms. Fair reductions result in omega normal forms if they are converging, and in normal forms in case of strong convergence. Rather surprisingly the infinite Church-Rosser property fails for both converging reductions and strongly converging reductions in ORTSs. Extending the notions head normal from and Boehm tree from lambda calculus, the infinite Church-Rosser property for non unifiable ORTSs is proved. ESA

N91-25722# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
REAL TIME PROCESS ALGEBRA
J. C. M. Beaten and J. A. Bergstra (Amsterdam Univ., Netherlands) Oct. 1990 48 p Submitted for publication Sponsored by Commission of the European Communities and Netherlands Organization for the Advancement of Research
(CWI-CS-R9053; ETN-91-99383) Copyright Avail: NTIS HC/MF A03

An axiom system ACP(rho) that incorporates real timed actions is described. Many examples are provided in order to explain the intuitive contents of the notation. ACP(rho) is a generalization of ACP (process algebra for synchronous communication). This implies that some of the axioms have to be relaxed and that ACP can be recovered as a special case from it. The purpose of ACP(rho) is to serve as a specification language for real time systems. The axioms of ACP(rho) explain its operational meaning in an algebraic form. ESA

N91-25723# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
COMPUTING BOOLEAN FUNCTIONS ON CAYLEY NETWORKS (EXTENDED ABSTRACT)
Evangelos Kranakis and Danny Krizanic (Rochester Univ., NY.) Oct. 1990 21 p Submitted for publication Sponsored by Netherlands Organization for the Advancement of Research
(CWI-CS-R9061; ETN-91-99391) Copyright Avail: NTIS HC/MF A03

The bit complexity (i.e., total number of bits transmitted) of computing boolean functions on anonymous Cayley networks is studied. Algorithms for computing Boolean functions in all such networks are given. The results give even better complexity bounds for several well known networks: rings, tori, hypercubes and star, pancake and bubble sort networks. ESA

N91-25724# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
EXPLICIT CANONICAL REPRESENTATIVES FOR WEAK BISIMULATION EQUIVALENCE AND CONGRUENCE
Jan J. M. M. Rutten Nov. 1990 23 p Sponsored by Commission of the European Communities and Netherlands Organization for the Advancement of Research
(CWI-CS-R9062; ETN-91-99392) Copyright Avail: NTIS HC/MF A03

A labelled transition system is considered having as labels a set of actions containing tau the silent move. Both for strong and weak bisimulation equivalence a model that maps every state of the system to a canonical representative of its equivalence class is defined. The latter model is obtained as an abstraction of the former. The main contribution is the fact that not only the existence of such representatives is established but that, moreover, an explicit (recursively defined) description is provided. The use of a recursive domain equation for the construction of tree like structures, which are used for these representatives, is crucial. ESA

N91-25725# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
FOUR DOMAINS FOR CONCURRENCY
J. W. deBakker and J. H. A. Warmerdam Nov. 1990 21 p Submitted for publication Sponsored by Netherlands Organization for the Advancement of Research
(CWI-CS-R9068; ETN-91-99398) Copyright Avail: NTIS HC/MF A03

Four domains for concurrency are given in a uniform way by means of domain equations. The domains are intended for modeling the four possible combinations of linear time versus branching time, and of interleaving versus noninterleaving concurrency. The linear time, noninterleaved domain is used to give operational and denotational semantics for a simple concurrent language with recursion. ESA

N91-25726# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
PROCESS ALGEBRA WITH GUARDS: COMBINING HOARE LOGIC WITH PROCESS ALGEBRA
Jan Friso Groote and Alban Ponse Dec. 1990 59 p Sponsored by Commission of the European Communities and Netherlands Organization for the Advancement of Research
(CWI-CS-R9069; ETN-91-99399) Copyright Avail: NTIS HC/MF A04

Process algebra with guards, comparable to the guards in guarded commands of conditions in common programming constructs such as if, then, else, fi and while, do, of are extended. The extended language is provided with an operational semantics based on transitions between pairs of a process and a (data) state. The data states are given by a data environment that also defines in which data states guards hold and how actions (nondeterministically) transform these states. The operational semantics studied is modulo strong bisimulation equivalence. For basic process algebra (without operators for parallelism) a small axiom system that is complete with respect to a general class of data environments is presented. Given a particular data environment S, three axioms are added to this system, which is then again complete, provided weakest preconditions are expressible and S is sufficiently deterministic. Process algebra with parallelism and guards is studied. A two phase calculus is provided that makes it possible to prove identities between parallel processes. This calculus is also complete. It is shown that partial correctness formulas can easily be expressed in this setting. Process algebra with guards is used to prove the soundness of a Hoare logic for linear processes by translating proofs in Hoare logic into proofs in process algebra. ESA

N91-25727# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.
A TIME SPLITTING METHOD FOR THE THREE-DIMENSIONAL SHALLOW WATER EQUATIONS
Erik D. deGoede Aug. 1990 21 p Submitted for publication Sponsored by Rijkswaterstraat and Netherlands Organization for the Advancement of Research
(CWI-NM-R9013; ETN-91-99406) Copyright Avail: NTIS HC/MF A03

A time splitting method for the three dimensional shallow water equations is described. The stability of this method neither depends on the vertical diffusion term nor on the terms describing the propagation of the surface waves. The method consists of two stages and requires the solution of a sequence of linear systems. For the solution of these systems a Jacobi type iteration method and a conjugate gradient iteration method are applied. The performance of both methods is accelerated by a technique based on smoothing. The resulting method is mass conservative and efficient on vector and parallel computers. The accuracy, stability and computational efficiency of this method is demonstrated for wind induced problems in a rectangular basin. ESA

N91-25728# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.
EULER: AN ADAPTIVE EULER CODE
H. T. M. vanderMaarel, P. W. Hemker, and C. T. H. Everaars Aug. 1990 36 p Sponsored in part by Netherlands Organization for the Advancement of Research

(Contract AERO-0003-C)
(CWI-NM-R9015; ETN-91-99408) Copyright Avail: NTIS HC/MF A03

The FORTRAN implementation of an algorithm to perform first order accurate two dimensional Euler flow computations on a self adaptive grid is described. The data structure used allows for multigrid convergence acceleration on locally refined grids, consisting of nested quadrilaterals. The discretization and the multigrid procedure are based on Osher's scheme and finite volumes. ESA

N91-25729# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.
A NOTE ON THE GRID MOVEMENT INDUCED BY MFE
Paul A. Zegeling and J. G. Blom Oct. 1990 15 p Submitted for publication
(Contract CWI-59-0922)
(CWI-NM-R9019; ETN-91-99412) Copyright Avail: NTIS HC/MF A03

Moving grid methods in one space dimension have become popular for solving several kinds of parabolic and hyperbolic partial difference equations (PDEs) involving fine scale structures such as steep moving fronts and emerging steep layers, pulses, shocks, etc. In two space dimensions, however, application of moving grid methods is less trivial than in one dimension. For some methods, e.g., those based on equidistributing principles, it is not even clear how to extend the underlying grid selection procedure to two dimensions. The moving finite element (MFE) method does not suffer from this drawback; its mathematical extension to two dimensions is trivial. However, because of the intrinsic coupling between the discretization of the PDE and the grid selection, the application of MFE, as for any other method, is not without difficulties. The node movement induced by MFE is described for various PDEs and some problems concerning the grid structure that can result from this movement are indicated. ESA

N91-25730# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.
NUMERICAL ANALYSIS OF TIME-DEPENDENT BOUSSINESQ MODELS
P. J. vanderHouwen, J. Mooiman, and F. W. Wubs (Groningen Rijksuniv., Netherlands) Oct. 1990 15 p Sponsored by Netherlands Organization for the Advancement of Research
(CWI-NM-R9020; ETN-91-99413) Copyright Avail: NTIS HC/MF A03

Numerical models for time dependent Boussinesq equations are analyzed. These equations arise when so called Boussinesq terms are introduced into the shallow water equations. The Boussinesq terms proposed by Katapodes and Dingemans are used. These terms generalize the constant depth terms given by Broer. The shallow water equations are discretized by using fourth order finite difference formulas for the space derivatives and a fourth order, explicit time integrator. The effect on the stability and accuracy of various discrete Boussinesq terms is investigated. Numerical experiments are presented in the case of a fourth order Runge-Kutta integrator. ESA

N91-25731# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.
RUNGE-KUTTA METHODS AND LOCAL UNIFORM GRID REFINEMENT
R. A. Trompert and J. G. Verwer Nov. 1990 53 p Submitted for publication Sponsored by Netherlands Organization for the Advancement of Research
(CWI-NM-R9022; ETN-91-99415) Copyright Avail: NTIS HC/MF A04

Local uniform grid refinement (LUGR) is an adaptive grid technique for computing solutions of partial differential equations possessing sharp spatial transitions. Using nested, finer and finer uniform subgrids, the LUGR technique refines the space grid locally around these transitions, so as to avoid discretization on a very fine grid covering the entire physical domain. The LUGR technique is examined for time dependent problems when combined with static regridding. Static regridding means that in the course of the time evolution, the space grid is adapted at discrete times. The general class of Runge-Kutta methods for the numerical time integration is considered. Following the method of lines approach, a mathematical problem is developed. Parabolic and hyperbolic problems are addressed and attention is paid to the local error analysis. The central issue here is a refinement condition which is to underly the refinement strategy. By obeying this condition, spatial interpolation errors are controlled in a manner that the spatial accuracy obtained is comparable to the spatial accuracy on the finest grid if this grid would be used without any adaptation. A diagonally implicit Runge-Kutta method is discussed for illustration purposes, both theoretically and numerically. ESA

N91-25732# Technische Univ., Delft (Netherlands).
ON APPROXIMATE SYSTEM IDENTIFICATION WITH SYSTEM BASED ORTHONORMAL FUNCTIONS Ph.D. Thesis
Petrus Servatius Chr Heuberger 1991 219 p Sponsored by Shell Research B.V.
(ISBN-90-370-0045-2; ETN-91-99430) Avail: NTIS HC/MF A10

Aspects of the modeling process to describe dynamic processes are addressed. A distinction is made between the case that an existing model has to be approximated with a model of a lower complexity (model reduction) and the case that a model has to be created on the basis of measurement data of the dynamic process (system identification). Results contribute to the development of a situation in which a variety of methods is available to deal with model reduction and system identification in a comparable manner, such that the character and result of the approximation are thoroughly understood. Model reduction and the application of orthonormal functions for model descriptions and system identification are addressed. The use of discrete Laguerre polynomials for the description of signals and systems is analyzed and extended to a broader class of orthonormal functions that are induced by linear systems. The estimation of ARX and FIR models in orthogonal terms is considered in detail. The application of orthonormal functions combined with classical identification methods is concluded to yield a promising approach to deal with approximate system identification. ESA

N91-25733# New York Univ., New York. Inst. of Mathematical Sciences.
LAPLACE'S EQUATION AND THE DIRICHLET-NEUMANN MAP IN MULTIPLY CONNECTED DOMAINS
A. Greenbaum, L. Greengard, and G. B. McFadden (National Inst. of Standards and Technology, Gaithersburg, MD.) Mar. 1991 30 p
(Contract DE-FG02-88ER-25053)
(DE91-011069; DOE/ER-25053/5) Avail: NTIS HC/MF A03

A variety of problems in material science and fluid dynamics require the solution of Laplace's equation in multiply connected domains. Integral equation methods are natural candidates for such problems, since they discretize the boundary alone, require no special effort for free boundaries, and achieve superalgebraic convergence rates on sufficiently smooth domains in two space dimensions, regardless of shape. Current integral equation methods for the Dirichlet problem, however, require the solution of M independent problems of dimension N, where M is the number of boundary components and N is the total number of points in the discretization. In this paper, we present a new boundary integral equation approach, valid for both interior and exterior problems, which requires the solution of a single linear system of dimension N + M. We solve this system by making use of an iterative method (GMRES) combined with the last multipole method for the rapid calculation of the necessary matrix vector products. For a two-dimensional system with 200 components and 100 points on each boundary, we gain a speedup of a factor of 100 from the new analytic formulation and a factor of 50 from the fast multipole method. The resulting scheme brings large scale calculations in extremely complex domains within practical reach. DOE

N91-25734# Lawrence Livermore National Lab., CA.
ANALYSIS OF MULTI-WAVELENGTH PYROMETRY USING NON-LINEAR CHI-SQUARE FITS AND MONTE CARLO METHODS
G. R. Gathers Mar. 1991 30 p Presented at the 11th Symposium on Thermophysical Properties, Boulder, 23-27 Jun. 1991
(Contract W-7405-eng-48)
(DE91-011185; UCRL-JC-105620; CONF-9106176-1) Avail: NTIS HC/MF A03

An analysis of multi-wavelength pyrometry is made using Monte Carlo methods to evaluate the measurement error as a function of temperature for 3, 4, 5, and 6 channels. Both a graybody and an emissivity with linear wavelength dependence are considered. Chi(sup 2) is calculated using the observed intensity in each channel, and is minimized with respect to the temperature and the emissivity coefficients, using the Levenberg-Marquardt method. The influence of spectral span of the channels, and the weight function used in the Chi(sup 2) fit, are examined. For the case of linear wavelength dependence, the solutions are found to be non-unique, even with 6 channels. The results show little improvement of precision with increasing number of channels beyond 4 channels when the non-linear variable T is free. Both the spectral span and the weight function are shown to be important variables. DOE

N91-25735# Argonne National Lab., IL.
EXTRAPOLATION-BASED BOUNDARY ELEMENT QUADRATURE
J. N. Lyness 1990 10 p Presented at the Numerical Methods in Applied Science and Industry, Torino (Italy), 18-21 Jun. 1990
(Contract W-31-109-eng-38)
(DE91-011175; ANL/CP-72305; CONF-9006335-1) Avail: NTIS HC/MF A02

The classical Euler Maclaurin summation formula expresses the discretization error made by the trapezoidal rule approximation to a finite integral as an asymptotic expansion in the mesh ratio. As such, it plays a significant role in the theory of numerical quadrature. In particular, it forms the basis for Richardson's deferred approach to the limit, also known as Romberg integration and as quadrature by extrapolation. In this review, we draw attention to some more recent theory, based on the Euler Maclaurin summation formula (or expansion). During the past 25 years, this theory has undergone significant development. Briefly, the expansion has been systematized to embrace all quadrature rules. It has been generalized to the N-dimensional cube and to the N-dimensional simplex. Moreover, a significant generalization has been made to cover functions having algebraic and logarithmic singularities at vertices. In this article we discuss some of these developments in the context of their possible use to analyze finite elements. In general, no proofs are provided, but references are given. DOE

N91-25736# Sandia National Labs., Albuquerque, NM.
STABILITY AND ACCURACY OF DIFFERENCING SCHEMES FOR VISCOPLASTIC MODELS IN WAVECODES
S. A. Silling Mar. 1991 27 p
(Contract DE-AC04-76DP-00789)
(DE91-011265; SAND-91-0141) Avail: NTIS HC/MF A03

The numerical stability and truncation error of a family of differencing schemes for viscoplastic constitutive relations in wavecodes is investigated. A von Neumann stability analysis is performed for a one-dimensional model problem. This analysis identifies two differencing methods which have no restriction on the time step size beyond the usual Courant-Friedrichs-Lewy condition. One of these methods is first-order accurate, and the other is second-order accurate. Implementation of one of these methods in the three-dimensional wavecode CTH is discussed. DOE

N91-25737# Los Alamos National Lab., NM.
FEHMN 1.0: FINITE ELEMENT HEAT AND MASS TRANSFER CODE
G. Zyvoloski, Z. Dash, and S. Kelkar Apr. 1991 118 p
(Contract W-7405-eng-36)
(DE91-011347; LA-12062-MS) Avail: NTIS HC/MF A06

A computer code is described which can simulate non-isothermal multiphase multicomponent flow in porous media. It is applicable to natural-state studies of geothermal systems and ground-water flow. The equations of heat and mass transfer for multiphase flow in porous and permeable media are solved using the finite element method. The permeability and porosity of the medium are allowed to depend on pressure and temperature. The code also has provisions for movable air and water phases and noncoupled tracers; that is, tracer solutions that do not affect the heat and mass transfer solutions. The tracers can be passive or reactive. The code can simulate two-dimensional, two-dimensional radial, or three-dimensional geometries. A summary of the equations in the model and the numerical solution procedure are provided in this report. A user's guide and sample problems are also included. The main use of FEHMN will be to assist in the understanding of flow fields in the saturated zone below the proposed Yucca Mountain Repository. DOE

N91-25738# Wisconsin Univ., Madison. Plasma Physics Research.
EXTRACTION OF DYNAMICAL EQUATIONS FROM CHAOTIC DATA
G. Rowlands (Warwick Univ., Coventry, England) and J. C. Sprott Feb. 1991 18 p
(Contract DE-FG02-85ER-53198)
(DE91-011762; DOE/ER-53198/170) Avail: NTIS HC/MF A03

A method is described for extracting from a chaotic time series a system of equations whose solution reproduces the general features of the original data even when these are contaminated with noise. The equations facilitate calculation of fractal dimension, Lyapunov exponents and short-term predictions. The method is applied to data derived from numerical solutions of the logistic equation, the Henon equations, the Lorenz equations, and the Roessler equations. DOE

N91-25739*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
HIGH-ORDER POLYNOMIAL EXPANSIONS (HOPE) FOR FLUX-VECTOR SPLITTING
Meng-Sing Liou and Chris J. Steffen, Jr. 1991 7 p Presented at the International Conference on Computational Engineering Science, Melbourne, Australia, 11-16 Aug. 1991
(NASA-TM-104452; E-6293; NAS 1.15:104452) Avail: NTIS HC/MF A02 CSCL 12A

The Van Leer flux splitting is known to produce excessive numerical dissipation for Navier-Stokes calculations. Researchers attempt to remedy this deficiency by introducing a higher order polynomial expansion (HOPE) for the mass flux. In addition to Van Leer's splitting, a term is introduced so that the mass diffusion error vanishes at M equals 0. Several splittings for pressure are proposed and examined. The effectiveness of the HOPE scheme is illustrated for 1-D hypersonic conical viscous flow and 2-D supersonic shock-wave boundary layer interactions. Also, the authors give the weakness of the scheme and suggest areas for further investigation. Author

N91-25740# Comision Nacional de Energia Atomica, Buenos Aires (Argentina). Gerencia de Desarrollo.
SOLUTION OF MOVING BOUNDARY PROBLEMS WITH IMPLICIT BOUNDARY CONDITION [RESOLUCION DE UN PROBLEMA DE FRONTERA MOVIL CON CONDICION DE BORDE IMPLICITA]
E. A. Moyano 1990 28 p In SPANISH
(DE91-623308; CNEA-NT-1/90) Avail: NTIS HC/MF A03

An algorithm that solves numerically a model for studying one dimensional moving boundary problems, with implicit boundary condition, is described. Landau's transformation is used, in order to work with a fixed number of nodes at each instant. Then, it is necessary to deal with a parabolic partial differential equation, whose diffusive and convective terms have variable coefficients.

The partial differential equation is implicitly discretized, using Laasonen's scheme, always stable, instead of employing Crank-Nicholson scheme, as it has been done by Ferris and Hill. Fixed time and space steps (Delta t, Delta (xi)) are used, and the iteration is made with variable positions of the interface, i.e., varying (delta)s until a boundary condition is satisfied. The model has the same features of the oxygen diffusion in absorbing tissue. It would be capable of estimating time variant radiation treatments of cancerous tumors. DOE

65 STATISTICS AND PROBABILITY

Includes data sampling and smoothing; Monte Carlo method; and stochastic processes.

N91-25741*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
MODEL REDUCTION BY TRIMMING FOR A CLASS OF SEMI-MARKOV RELIABILITY MODELS AND THE CORRESPONDING ERROR BOUND
Allan L. White and Daniel L. Palumbo May 1991 11 p Presented at the Annual Reliability and Maintainability Symposium, 1990
(NASA-TP-3089; L-16862; NAS 1.60:3089) Avail: NTIS HC/MF A03 CSCL 12A

Semi-Markov processes have proved to be an effective and convenient tool to construct models of systems that achieve reliability by redundancy and reconfiguration. These models are able to depict complex system architectures and to capture the dynamics of fault arrival and system recovery. A disadvantage of this approach is that the models can be extremely large, which poses both a model and a computational problem. Techniques are needed to reduce the model size. Because these systems are used in critical applications where failure can be expensive, there must be an analytically derived bound for the error produced by the model reduction technique. A model reduction technique called trimming is presented that can be applied to a popular class of systems. Automatic model generation programs were written to help the reliability analyst produce models of complex systems. This method, trimming, is easy to implement and the error bound easy to compute. Hence, the method lends itself to inclusion in an automatic model generator. Author

N91-25742# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
BOOTSTRAPPING U-QUANTILES
R. Helmers, P. Janssen, and N. Veraverbeke (Limburgs Univ., Diepenbeek, Belgium) Jul. 1990 11 p Presented at the 214th IMS Meeting, East Lansing, MI, 15-16 May 1990 Submitted for publication Sponsored by Netherlands Organization for the Advancement of Research
(CWI-BS-R9021; ETN-91-99350) Copyright Avail: NTIS HC/MF A03

The asymptotic consistency of the bootstrap approximation for generalized quantiles of U statistic structure (U quantiles for short) is established. The same method of proof also yields the asymptotic accuracy of the bootstrap approximation in this case. Aplications to location and spread estimators, such as the classical sample quantile, the Hodges-Lehmann estimator of location and a spread estimator proposed by Bickel and Lehmann are given. The method of proof for the asymptotic consistency relies on an idea of Sheehy and Wellner (1988), who treat the sample median. ESA

N91-25743# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
NESTED MONTE CARLO STUDY OF RANDOM PACKING ON THE SPHERE
R. P. C. Rodgers (California Univ., San Francisco.) and A. J. Baddeley Jul. 1990 20 p Submitted for publication Sponsored by Netherlands Organization for the Advancement of Research
(CWI-BS-R9023; ETN-91-99352) Copyright Avail: NTIS HC/MF A03

Two random sequential packing processes in which spheres of unit radius are randomly attached to the surface of a fixed unit sphere are considered. Independent random spheres are generated and added successively, provided there is no overlap with previous spheres. In the first model, the process stops when a trial sphere intersects one of the previously accepted spheres. In the second model, 'random sequential packing', any such overlapping trial sphere is described and the next random sphere is tried, until it is impossible to add any further spheres. Previous workers have conjectured convincingly that no exact analytical solution is possible for this type of problem. Monte Carlo simulation are used to estimate transitions probabilities for the two models. Because some probabilities are extremely small, a simulation using independent repetitions of the model would be inefficient. A branching process of conditionally binomial trials is designed and over 10 to the 8th power trials on a supercomputer are performed. ESA

N91-25744# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
GRADIENT PROJECTION FOR NONPARAMETRIC MAXIMUM LIKELIHOOD ESTIMATION WITH INTERVAL CENSORED DATA
Dick M. Bakker Sep. 1990 25 p Sponsored by Netherlands Organization for the Advancement of Research
(CWI-BS-R9027; ETN-91-99356) Copyright Avail: NTIS HC/MF A03

A well known way of computing the Non Parametric Maximum Likelihood Estimator (NPMLE) of a distribution function of censored observations is the EM algorithms, which is known as slow and hence not practicable, especially in simulation studies. In the case of interval censored observations, computing the NPMLE can be considered as a general strictly concave programming problem and a gradient projection method can be used to maximize a concave function subject to a number of constraints. This is worked out for interval censored observations with two or more censoring points. Some simulation results are given. ESA

N91-25745# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
ON SECOND ORDER OPTIMALITY OF REGULAR PROJECTIVE ESTIMATORS, PART 1
Kacha E. Dzhaparidze and Peter C. Spreij (Vrije Univ., Amsterdam, Netherlands) Oct. 1990 21 p Sponsored by Netherlands Organization for the Advancement of Research
(CWI-BS-R9029-Pt-1; ETN-91-99358) Copyright Avail: NTIS HC/MF A03

In the partially specified statistical models the class of regular estimators having linear representation is defined, and the best among them is sought in the sense of asymptotic second order characteristics. The best estimator is called projective, as it is defined by taking certain projections of scoring functions. In the special case of fully (or partially) specified models it coincides asymptotically with the maximum (partial) likelihood estimator, in signal plus noise models with the Gauss-Markov estimator, and finally in time series models with the so called Gaussian estimator. Thus the unified approach is suggested for determining optimal estimators in different statistical models usually separately treated. ESA

N91-25746# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
BOUNDS FOR THE INTERNAL AVAILABILITY DISTRIBUTION
Pieter Wartenhorst Oct. 1990 12 p Submitted for publication Sponsored by Netherlands Organization for the Advancement of Research
(CWI-BS-R9031; ETN-91-99360) Copyright Avail: NTIS HC/MF A03

Bounds are presented for the interval availability distribution of

a two state single component system which alternates between 'up' and 'down' state. Numerical computation is considered for the case in which both up and down times are distributed according to mixed Erlang distributions. Some numerical examples are presented and the results are compared with those obtained from the uniformization technique. ESA

N91-25747# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
ON ITERATIVE ESTIMATORS
Kacha E. Dzhaparidze Dec. 1990 30 p Presented at the Iterative Procedures in Statistics Seminar, 3 Apr. 1990 Sponsored by Netherlands Organization for the Advancement of Research
(CWI-BS-R9036; ETN-91-99363) Copyright Avail: NTIS HC/MF A03

Optimal recommendations for drawing statistical inference about unknown parameters are usually based on optimization of some criterion function (e.g., likelihood, least squares, etc.). This optimization is then carried out over all admissible values of parameters, so an unconstrained global optimum is sought. Typically the criterion function is taken asymptotically quadratic, as sample size increases, of the parameter value. Methods developed in numerical analysis (quasi-Newton or conjugate gradient methods or rather their appropriate stochastic modifications) which possess the so called quadratic termination property are applied to these optimization problems: the minimum of a quadratic function is found in at most d iterations where d is the number of unknowns. As applied to an asymptotically quadratic criterion function, such methods lead to asymptotically efficient estimators for a d dimensional parameter in at most d iterates. ESA

N91-25748# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Computer Science.
COMPLETENESS OF COMBINATIONS OF CONSTRUCTOR SYSTEMS
Aart Middeldorp and Yoshihito Toyama (Nippon Telegraph and Telephone Public Corp., Tokyo, Japan) Oct. 1990 21 p Sponsored by Commission of the European Communities and Netherlands Organization for the Advancement of Research
(CWI-CS-R9058; ETN-91-99388) Copyright Avail: NTIS HC/MF A03

A term rewriting system is called complete if it is both confluent and strongly normalizing. Barendregt and Klop showed that the disjoint union of complete term rewriting systems does not need to be complete. In other words, completeness is not a modular property of term rewriting systems. Toyama, Klop, and Bartendregt showed that completeness is a modular property of left linear TRS's. A study which shows that it is sufficient to impose the constructor discipline for obtaining the modularity of completeness is presented. This result is a simple consequence of a quite powerful divide and conquer technique for establishing completeness of such constructor systems. The approach is not limited to systems which are composed of disjoint parts. The importance of the method is that a given constructor system may be divided into parts which possibly share function symbols and rewrite rules in order to infer completeness. A similar technique is obtained for semi completeness, i.e., the combination of confluence and weak normalization. ESA

N91-25129*# Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.
KNOWLEDGE ACQUISITION FOR EXPERT SYSTEMS USING STATISTICAL METHODS
Brenda L. Belkin and Robert F. Stengel *In* AGARD, Knowledge Based System Applications for Guidance and Control Apr. 1991 17 p (For primary document see N91-25121 17-04)
(Contract NGL-31-001-252; DAAG29-84-K-0048)
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66 SYSTEMS ANALYSIS

Includes mathematical modeling; network analysis; and operations research.

N91-25749*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DEVELOPMENT OF AN ANALYTICAL TOOL TO STUDY POWER QUALITY OF AC POWER SYSTEMS FOR LARGE SPACECRAFT
L. Alan Kraft (Valparaiso Univ., IN.) and M. David Kankam 1991 7 p Presented at the 26th Intersociety Energy Conversion Engineering Conference, Boston, MA, 4-9 Aug. 1991; sponsored by the American Nuclear Society, SAE, the American Chemical Society, AIAA, ASME, IEEE, and American Inst. of Chemical Engineers
(NASA-TM-104451; E-6292; NAS 1.15:104451) Avail: NTIS HC/MF A02 CSCL 12B

A harmonic power flow program applicable to space power systems with sources of harmonic distortion is described. The algorithm is a modification of the Electric Power Research Institute's HARMFLO program which assumes a three phase, balanced, AC system with loads of harmonic distortion. The modified power flow program can be used with single phase, AC systems. Early results indicate that the required modifications and the models developed are quite adequate for the analysis of a 20 kHz testbed built by General Dynamics Corporation. This is demonstrated by the acceptable correlation of present results with published data. Although the results are not exact, the discrepancies are relatively small. Author

N91-25750# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Avionics and Aerospace Medical Panel.
MISSION PLANNING SYSTEMS FOR TACTICAL AIRCRAFT (PRE-FLIGHT AND IN-FLIGHT)
May 1991 51 p Original contains color illustrations
(AGARD-AR-296; ISBN-92-835-0615-4) Copyright Avail: NTIS HC/MF A04; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The concept of planning a mission for a military aircraft is probably as old and well established as that of the military aircraft itself, but until recently the methodology and technology associated with mission planning had received only limited attention from scientists and engineers. The last few years have, however, seen a marked increase in the attention given to mission planning both by the users, who are demanding improved facilities, and by the suppliers, who are able to provide increasingly more capable systems. As a result, the air forces of many of the NATO countries are procuring new and advanced mission planning systems that have capabilities far in advance of those previously available. Author

N91-25751# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
DUAL DECOMPOSITION OF SINGLE-MACHINE SCHEDULING PROBLEMS
S. L. vandeVelde May 1990 16 p Submitted for publication Sponsored by Netherlands Organization for the Advancement of Research
(CWI-BS-R9009; ETN-91-99349) Copyright Avail: NTIS HC/MF A03

A framework for Langrangian duality theory for single machine scheduling with minsum objectives is proposed, which induces a dual decomposition of such problems. The dual decomposition method offers promising opportunities for the design of approximative and enumerative algorithms. The method is developed through analysis of the problem of minimizing the total weighted completion time subject to precedence constraints. ESA

N91-25752# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
COMBINATORICS IN OPERATIONS RESEARCH
Antoon W. J. Kolen and Jan Karel Lenstra (Technische Univ., Eindhoven, Netherlands) Sep. 1990 34 p Submitted for publication Sponsored by Netherlands Organization for the Advancement of Research
(CWI-BS-R9024; ETN-91-99353) Copyright Avail: NTIS HC/MF A03

A collection of examples of the use of combinatorial techniques in practical decision situations is presented. The emphasis is on the description of real world problems, the formulation of mathematical models, and the development of algorithms for their solution. Related models and applications are surveyed. ESA

N91-25753# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
A NEW LOWER BOUND APPROACH FOR SINGLE-MACHINE MULTICRITERIA SCHEDULING
J. A. Hoogeveen and S. L. vandeVelde Sep. 1990 11 p Submitted for publication Sponsored by Netherlands Organization for the Advancement of Research
(CWI-BS-R9026; ETN-91-99355) Copyright Avail: NTIS HC/MF A03

The concept of maximum potential improvement has played an important role in computing lower bounds for single machine scheduling problems with composite objective functions that are linear in the job completion times. A method for lower bound computation called objective splitting is introduced. The method is shown to dominate the maximum potential improvement method in terms of speed and quality. ESA

N91-25754# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Operations Research, Statistics, and System Theory.
NEW LOWER AND UPPER BOUNDS FOR SCHEDULING AROUND A SMALL COMMON DUE DATE
J. A. Hoogeveen, H. Oosterhout, and S. L. vandeVelde (Universiteit Twente, Enschede, Netherlands) Oct. 1990 14 p Submitted for publication Sponsored by Netherlands Organization for the Advancement of Research
(CWI-BS-R9030; ETN-91-99359) Copyright Avail: NTIS HC/MF A03

Suppose a set of n jobs has to be scheduled on a single machine, which can handle no more than one job at a time. The problem is to find a schedule that minimizes the sum of deviations of the job completion times from a given common due date that is smaller than the sum of the processing times. This problem is known to be NP hard. There exists a pseudo polynomial algorithm that is able to solve instances up to 1000 jobs. Branch and bound algorithms can solve instances up to only 25 jobs. Lagrangian relaxation is applied to find new lower and upper bounds that coincide for virtually all instances with n not too small. Both bounds are computed in O (n log n) time. For the case that these bounds do not concur, refinements of the bounds are presented which are obtained by solving a subset sum problem to optimality by a pseudo polynomial algorithm; this subset sum problem is of considerably smaller dimension than the common due data problem. Extension of the lower bounding approach and the heuristic to the problem where all early completions are weighted by a common weight alpha and all late completions by a common weight beta is shown. ESA

N91-25136# Grumman Aerospace Corp., Bethpage, NY. Technology Development Section.
DESIGN AND SIMULATION OF AN ADVANCED AIRBORNE EARLY WARNING SYSTEM
Chien Y. Huang and Manikant D. Lodaya *In* AGARD, Knowledge Based System Applications for Guidance and Control Apr. 1991 10 p (For primary document see N91-25121 17-04)
Copyright Avail: NTIS HC/MF A12; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

67 THEORETICAL MATHEMATICS

Includes topology and number theory.

No abstracts in this category.

70 PHYSICS (GENERAL)

For precision time and time interval (PTTI) see *35 Instrumentation and Photography;* for geophysics, astrophysics or solar physics see *46 Geophysics, 90 Astrophysics,* or *92 Solar Physics.*

N91-25755*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
THE 22ND ANNUAL PRECISE TIME AND TIME INTERVAL (PTTI) APPLICATIONS AND PLANNING MEETING
Richard L. Sydnor, ed. May 1990 618 p Meeting held in Vienna, VA, 4-6 Dec. 1990
(NASA-CP-3116; NAS 1.55:3116; Rept-91B00084) Avail: NTIS HC/MF A99 CSCL 20C

Papers presented at the 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting are compiled. The following subject areas are covered: Rb, Cs, and H-based frequency standards and cryogenic and trapped-ion technology; satellite laser tracking networks, GLONASS timing, intercomparison of national time scales and international telecommunications; telecommunications, power distribution, platform positioning, and geophysical survey industries; military communications and navigation systems; and dissemination of precise time and frequency by means of GPS, GLONASS, MILSTAR, LORAN, and synchronous communication satellites. For individual titles, see N91-25756 through N91-25806.

N91-25756*# Harvard Univ., Cambridge, MA.
KEYNOTE ADDRESS: THE PAST, PRESENT, AND FUTURE OF ATOMIC TIME
Norman F. Ramsey *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 1-7 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

The early history of atomic time and frequency standards is reviewed. The most accurate and stable present standards are described. Prospective future improvements are discussed, particularly those with laser cooling and with trapped ions and atoms. Author

N91-25757*# Observatoire Cantonal, Neuchatel (Switzerland).
THE CLASSICAL MICROWAVE FREQUENCY STANDARDS
Giovanni Busca, Pierre Thomann, Bernier Laurent-Guy, Philippe Willemin, and Hartmut S. Schweda *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 9-18 Sponsored in part by CERS, Switzerland; ESA; and Swiss Federal Office of Metrology (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

Some key problems are presented encountered in the classical microwave frequency standards which are still not solved today. The point of view expressed benefits from the experience gained both in the industry and in the research lab, on the following classical microwave frequency standards: active and passive H, conventional and laser pumped Cs beam tube, small conventional and laser pumped Rubidium. The accent is put on the Rubidium standard. Author

N91-25758*# Hewlett-Packard Labs., Palo Alto, CA.
THE STATUS OF CESIUM BEAM FREQUENCY STANDARDS
Leonard S. Cutler *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 19-27 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

There has been a lot of progress in cesium beam frequency standards in the last few years some of which will be reported here. Optical pumping is being pursued actively in a number of laboratories. Optically slowed and cooled beams have been demonstrated as well as traps for cold neutral atoms. The microwave cavity performance with regard to local phase shift at the beam holes was improved by use of carefully designed and built ring structures for the cavity ends. Work is being done on improvements in electronics with some emphasis on use of digital circuitry and microprocessors. The frequency pulling due to microwave Delta M = +/- 1 transitions (Ramsey pulling) was analyzed and shown to be important. Status of cesium beam frequency standards in some of the laboratories as well as some of the commercial work is discussed. Optical pumping and detection are discussed. Author

N91-25759*# Smithsonian Astrophysical Observatory, Cambridge, MA.
STATE OF THE ART AND FUTURE DIRECTIONS FOR THE ATOMIC HYDROGEN MASER c36
Robert F. C. Vessot *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 29-51 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20E

The present status of technology development for atomic hydrogen masers (H-masers) is reviewed. The limitations to frequency stability and accuracy are discussed with emphasis on the problems associated with cavity resonator instability and the lack of reproducibility and stability of the storage volume wall coating frequency shift. New types of coating developed in the Soviet Union and better, cavity resonator materials, are expected to make possible frequency at the 10(exp -16) level at 10(exp 4) sec. Better control of systematic effects should extend the long-term stability to levels better than 10(exp -15) for intervals beyond one day. Present use of H-masers as flywheel oscillators in timekeeping systems is discussed as is the outlook for the future cryogenic and room temperature H-masers as flywheel oscillators to operate very high resolution frequency discriminators based on the newly evolving technology of trapped and cooled ions and atoms. Author

N91-25760*# National Inst. of Standards and Technology, Boulder, CO. Time and Frequency Div.
TRAPPED-ION FREQUENCY STANDARDS c72
David J. Wineland, W. M. Itano, J. C. Bergquist, J. J. Bollinger, D. J. Heinzen, C. H. Manney, F. L. Moore, M. G. Raizen, and C. S. Weimer *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 53-60 Sponsored by AFOSR and ONR (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20H

Frequency standards based on stored atomic ions are briefly reviewed. Specific examples are chosen to illustrate what is currently possible. Both rf/microwave and optical devices are discussed. The present limitations to existing experiments and possibilities for future improvement are outlined. Author

N91-25761*# SEPA S.p.A., Turin (Italy).
INTER-SATELLITE TIME TRANSFER: TECHNIQUES AND APPLICATIONS c32
Edoardo Detoma and S. Clark Wardrip (Bendix Field Engineering Corp., Santa Maria, CA.) *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 61-86 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 17B

A brief review is presented of the well known time transfer techniques that have been studied and tested throughout the years. The applicability of time transfer techniques to a timing service as provided through a TDRS/DRS System, the problems related to the choice of the timing signal within the constraints imposed by the existing systems, and the possible practical implementations, including a description of the time synchronization support via TDRSS to the Gamma Ray Observatory (GRO) are discussed. Author

N91-25762*# Leeds Univ. (England). Dept. of Electronic and Electrical Engineering.
CURRENT GPS/GLONASS TIME REFERENCE AND UTC c04
Peter Daly *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 87-95 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 17G

The world's two global satellite navigation systems, GPS and GLONASS, will both become operational during the early 1990's. Each will offer, independently of the other, precise location and time transfer continuously anywhere in the world and indeed in space itself. Many potential users, in particular the civil aviation community, are keenly interested in a joint GPS/GLONASS operation since it would offer substantial advantages in defining and maintaining the integrity of the navigation aid. The question arises of compatibility of GPS/GLONASS from the point of view of satellite on-board clocks, their system references, their national standards and ultimately UTC. Results are presented on the characterization of GLONASS system and spacecraft clocks as compared to their Navstar GPS counterparts. Author

N91-25763*# Vsesoyuznyi Nauchno-Issledovatelskii Inst. Radiatsionnoi Tekhniki, Moscow (USSR).
USSR NATIONAL TIME UNIT KEEPING OVER LONG INTERVAL USING AN ENSEMBLE OF H-MASERS
N. B. Koshelyaevsky and S. B. Pushkin *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 97-115 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

The U.S.S.R. State Time and Frequency Service (STFS) is discussed. The STFS is responsible for time and frequency measurement unification both in the field of atomic, TA(SU) and UTC(SU) and universal time UT1(SU) over the whole territory of the U.S.S.R. The U.S.S.R. national time unit keeping over long interval using an ensemble of H-masers is also discussed. Author

N91-25764*# Istituto Elettrotecnico Nazionale (Galileo Ferraris), Turin (Itlay).
TIME AND FREQUENCY COMPARISONS IN EUROPE BY MEANS OF ECS 5 GEOSTATIONARY SATELLITE
Franco Cordara, V. Pettiti, A. Cenci, M. Fermi, and C. Sciarretta (Telespazio, S.p.A., Rome, Italy) *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 117-130 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

A time synchronization experiment between some European laboratories using the passive television method applied to the signals broadcasted by Eutelsat I-F5 telecommunication satellite was completed in 1990. The results obtained in the last period, when also range measurements from a Telespazio ground station were performed, are analyzed to evaluate the accuracy level of the time comparisons corrected for the effect of the satellite movement with position data obtained either from the European Space Agency (ESA) or from orbit determination with range data entered into GEODYN program of NASA/GSFC. Author

N91-25765*# Ministry of Posts and Telecommunications, Ibaraki (Japan). Communications Research Lab.
A HIGHLY STABLE CRYSTAL OSCILLATOR APPLIED TO GEODETIC VLBI EXPERIMENT
Hitoshi Kiuchi and Jun Amagai *In* JPL, The 22nd Annual Precise

Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 131-144 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

Instead of a hydrogen maser, a carefully selected Crystal oscillator which is phase locked to a Cesium (Cs) frequency standard of a geodetic VLBI experiment. The domestic VLBI experiment with 55 km baseline using the Crystal oscillator at one end was made in Japan and the obtained error of the baseline vector components were 4 cm, and that of the baseline length was 3 cm. This system may be operated after only 2 hours warm up. These results coincides with those of conventional geodetic Laser ranging and VLBI using a hydrogen maser within the formal error. A VLBI experiment with over 1000 km baselines were carried out successfully from October 1988, and over 11000 km baseline between Japan and Antarctica was carried out successfully in January 1990. Author

N91-25766*# National Inst. of Standards and Technology, Boulder, CO.
GPS TIME TRANSFER WITH IMPLEMENTATION OF SELECTIVE AVAILABILITY
David W. Allan, Michel P. Granveaud, William J. Klepczynski, and Wlodzimierz W. Lewandowski (Bureau International des Poids et Mesures, Sevres, France) *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 145-155 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

The international community of time metrology is facing a major challenge with the Selective Availability (SA) degradation of GPS satellite signals. At present there are 6 Block 1 satellites and 8 Block 2 satellites operating. According to the policy of the U.S. Department of Defence the Block 1 satellite signals will not be degraded, but these satellites are old with a finite life. The Block 2 satellites, which have all been launched since 1988, were subject to Selective Availability from March 25, 1990. The effect of SA should be to limit precision to about 100 meters for navigation and 167 ns for timing. A study was conducted in order to understand the nature of the actual introduced degradation, and to elaborate the means of removing the effects of this degradation on time transfer. This study concerns the time extraction from GPS satellites at NIST, USNO and Paris Observatory, and the comparison of atomic clocks between these laboratories by common view approach. The results show that when using the data taken over several days the time extraction can be achieved with uncertainty of a few tens of nanoseconds, while strict common-view has removed entirely the effects of SA during the periods under study. Author

N91-25767*# Istituto Elettrotecnico Nazionale (Galileo Ferraris), Turin (Itlay).
TIME SCALE ALGORITHM: DEFINITION OF ENSEMBLE TIME AND POSSIBLE USES OF THE KALMAN FILTER
Patrizia Tavella and Claudine Thomas (Bureau International des Poids et Mesures, Sevres, France) *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 157-169 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

The comparative study of two time scale algorithms, devised to satisfy different but related requirements, is presented. They are ALGOS(BIPM), producing the international reference TAI at the Bureau International des Poids et Mesures, and AT1(NIST), generating the real-time time scale AT1 at the National Institute of Standards and Technology. In each case, the time scale is a weighted average of clock readings, but the weight determination and the frequency prediction are different because they are adapted to different purposes. The possibility of using a mathematical tool, such as the Kalman filter, together with the definition of the time scale as a weighted average, is also analyzed. Results obtained by simulation are presented. Author

N91-25768*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
ULTRA-STABLE Hg(+) TRAPPED ION FREQUENCY STANDARD
John D. Prestage, G. John Dick, and Lute Maleki *In its* The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 171-185 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

A fieldable trapped ion frequency standard based on Hg-199(+) ions confined in a hybrid rf/dc linear ion trap is developed. This trap permits storage of large numbers of ions with reduced susceptibility to the second-order Doppler effect caused by the rf confining fields. In preliminary measurements a stability of 2 to 3 x 10(exp -15) was obtained for 10000 second averaging times. These measurements were carried out with a 120 mHz wide atomic resonance line for the 40.5 GHz clock transition with a second order Doppler shift from the rf trapping field of 6 x 10(exp -13). Author

N91-25769*# Quartz Research and Production Association, Gorky (USSR).
DESIGN AND INDUSTRIAL PRODUCTION OF FREQUENCY STANDARDS IN THE USSR
Nikolai A. Demidov and Adolph A. Uljanov *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 187-208 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

Some aspects of research development and production of quantum frequency standards, carried out in QUARTZ Research and Production Association (RPA), Gorky, U.S.S.R., were investigated for the last 25 to 30 years. During this period a number of rubidium and hydrogen frequency standards, based on the active maser, were developed and put into production. The first industrial model of a passive hydrogen maser was designed in the last years. Besides frequency standards for a wide application range, RPA QUARTZ investigates metrological frequency standards--cesium standards with cavity length 1.9 m and hydrogen masers with a flexible storage bulb. Author

N91-25770*# Aerospace Corp., Los Angeles, CA. Electronics Research Lab.
LONG-TERM MICROWAVE POWER DRIFT OF A CESIUM FREQUENCY STANDARD AND ITS EFFECT ON OUTPUT FREQUENCY
W. A. Johnson, Sarunas K. Karuza, and Frank J. Voit *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 209-219 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

It has been shown that the long-term frequency stability of a cesium (Cs) frequency standard is affected by variations in the standard's internal microwave power source. Studies were performed on a commercial Cs frequency standard for a period of 20 days, to determine the stability of its microwave power source. The results were then analyzed statistically, and the effects of microwave power drift on the standard's frequency stability were calculated. Author

N91-25771*# Edgerton, Germeshausen and Grier, Inc., Salem, MA.
RUBIDIUM ATOMIC FREQUENCY STANDARDS FOR GPS BLOCK IIR
William J. Riley *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 221-230 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

The Rubidium Atomic Frequency Standards (RAFS) were provided for the GPS Block IIR NAVSTAR satellites. These satellites will replenish and upgrade the space segment of the Global Positioning System in the mid 1990s. The GPS RAFS Rb

clocks are the latest generation of the high-performance rubidium frequency standards. They offer an aging rate in the low pp 10(exp 14)/day range and a drift-corrected 1-day stability in the low pp 10(exp 14) range. The Block IIR version of these devices will have improved performance, higher reliability, smaller size, and greater radiation hardness. The GPS Block IIR atomic clocks have a natural frequency configuration whereby they output a frequency of about 13.4 MHz that is a submultiple of the atomic resonance of Rb (or Cs). The RAFS operates at a low, fixed C-field for increased stability. The GPS Block IIR RAFS design, including the changes and improvements made, and the test results obtained are described. Author

N91-25772*# Burkhardt Monitoring Service, Glen Allen, VA.
PRECISE FREQUENCY CALIBRATION USING TELEVISION VIDEO CARRIERS c32
Edward E. Burkhardt *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 231-233 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 17B

The availability of inexpensive and quick precise frequency calibration methods is limited. VLF and GPS do offer precise calibration. However, antenna placement, cost of equipment, and calibration time place many restrictions on the user. The USNO maintained line-10 television Time of Coincidence (TOC) of station WTTG, channel 5, Washington, DC requires a frequency stable video carrier. This video carrier, 77.24 MHz is controlled by the same cesium beam standard controlling the TOC of line-10. Excellent frequency comparisons against this video carrier have been accomplished at 95 miles (153 km). With stable propagation and a three foot wire antenna, a part in 10(exp 9) can be determined in a few minutes. Inexpensive field equipment with a synthesized 1 kHz offset from the video carrier offers parts in 10(exp 11) calibrations in a few minutes using an oscilloscope as a phase comparator. Author

N91-25773*# Aerospace Corp., El Segundo, CA.
GEODETIC POSITIONING OF THE AEROSPACE ELECTRONICS RESEARCH LAB (ERL) OSBORNE TIME TRANSFER RECEIVER (TTR) USING THE GPS NAVSTAR BLOCK I SATELLITES
Anthony S. Liu *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 235-242 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

Aerospace has routinely processed the Osborne Time Transfer Receiver (TTR) data for the purpose of monitoring the performance of ground and GPS atomic clocks in near real-time with on-line residual displays and characterizing clock stability with Allan Variance calculations. Recently, Aerospace added the ability to estimate the TTR's location by differentially correcting the TTR's location in the WGS84 reference system. This new feature is exercised on a set of TTR clock phase data and Sub-meter accurate station location estimates of the TTR at the Aerospace Electronic Research Lab (ERL) are obtained. Author

N91-25774*# Ministry of Posts and Telecommunications, Ibaraki (Japan). Communications Research Lab.
PRECISE MEASUREMENT METHOD FOR IONOSPHERIC TOTAL ELECTRON CONTENT USING SIGNALS FROM GPS SATELLITES
Michito Imae, Hitoshi Kiuchi, Akihiro Kaneko, Shinichi Hama, and Chihiro Miki *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 243-251 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

A GPS codeless receiver called GTR-2 was for measuring total electron content (TEC) along the line of sight to the GPS satellite by using the cross correlation amplitude of the received P-code signals carried by L1(1575.42 MHz) and L2(1227.6 MHz). This equipment has the performance of uncertainty in the measurement of TEC of about 2 X 10(exp 16) electrons/sq m when a 10 dBi gain antenna was used. To increase the measurement performance, an upper version of GTR-2 called GTR-3 is planned which uses the phase information of the continuous signals obtained by making a cross correlation or multiplication of the received L1 and L2 P-code signals. By using the difference of these measured phases values, the ionospheric delay with the ambiguities of the periods of L1+L2 and L1-L2 signals can be estimated. Author

N91-25775*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
APPLICATION OF HIGH STABILITY OSCILLATORS TO RADIO SCIENCE EXPERIMENTS USING DEEP SPACE PROBES c32
Emil R. Kursinski *In its* The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 253-268 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 17B

The microwave telecommunication links between the earth and deep space probes have long been used to conduct radio science experiments which take advantage of the phase coherency and stability of these links. These experiments measure changes in the phase delay of the signals to infer electrical, magnetic and gravitational properties of the solar system environment and beyond through which the spacecraft and radio signals pass. The precision oscillators, from which the phase of the microwave signals are derived, play a key role in the stability of these links and therefore the sensitivity of these measurements. These experiments have become a driving force behind recent and future improvements in the Deep Space Network and spacecraft oscillators and frequency and time distribution systems. Three such experiments which are key to these improvements are briefly discussed and relationship between their sensitivity and the signal phase stability is described. The first is the remote sensing of planetary atmospheres by occultation in which the radio signal passes through the atmosphere and is refracted causing the signal pathlength to change from which the pressure and the temperature of the atmosphere can be derived. The second experiment is determination of the opacity of planetary rings by passage of the radio signals through the rings. The third experiment is the research for very low frequency gravitational radiation. The fractional frequency variation of the signal is comparable to the spatial strain amplitude the system is capable of detecting. A summary of past results and future possibilities for these experiments are presented. Author

N91-25776*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
ZERO-CROSSING DETECTOR WITH SUB-MICROSECOND JITTER AND CROSSTALK
G. John Dick, Paul F. Kuhnle, and Richard L. Sydnor *In its* The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 269-282 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

A zero-crossing detector (ZCD) was built and tested with a new circuit design which gives reduced time jitter compared to previous designs. With the new design, time jitter is reduced for the first time to a value which approaches that due to noise in the input amplifying stage. Additionally, with fiber-optic transmission of the output signal, crosstalk between units has been eliminated. The measured values are in good agreement with circuit noise calculations and approximately ten times lower than that for ZCD's presently installed in the JPL test facility. Crosstalk between adjacent units was reduced even more than the jitter. Author

N91-25777*# Sigma Tau Standards Corp., Tuscaloosa, AL.
HYDROGEN MASERS WITH CAVITY FREQUENCY SWITCHING SERVOS c36
Harry E. Peters, H. B. Owings, and Paul A. Koppang *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 283-292 (For

primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20E

The stability of the free-running hydrogen maser is limited by pulling of the unperturbed hydrogen transition frequency due to instability of the cavity resonance frequency. While automatic spin-exchange tuning is in principle the more basic and accurate method, the required beam intensity switching and the long servo time constant result in reduced stability for measuring intervals up to 10(exp 6) seconds. More importantly, the spin-exchange tuning method requires a second stable frequency source as a reference, ideally a second hydrogen maser, to get the best results. The cavity frequency switching servo, on the other hand, has very little effect on the maser short term stability, and is fast enough to correct for cavity drift while maintaining the cavity at the spin-exchange tuned offset required to minimize instability due to beam intensity fluctuations. Not only does the cavity frequency switching servo not require a second stable frequency source, but the frequency reference is the atomic hydrogen radiated beam signal, so that no extra RF connections need be made to the cavity, and externally generated signals that would perturb the hydrogen atom need not be transmitted through the cavity. The operation of the cavity frequency switching stabilization method is discussed and the transient response of the servo and certain other aspects of the technique that have potential for achieving improved basic accuracy are illustrated. Author

N91-25778*# Aerospace Corp., Los Angeles, CA. Chemistry and Physics Lab.
FREQUENCY SHIFTS IN A RUBIDIUM FREQUENCY STANDARD DUE TO COUPLING TO ANOTHER STANDARD
Bernardo Jaduszliwer, R. A. Cook, and R. P. Frueholz *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 293-300 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

Highly reliable timing system, such as used on board satellites, may incorporate a hot standby atomic clock besides the active one. RF couplings between them may affect the performance of the active clock. The effect of such couplings between two rubidium atomic clocks was investigated, and it was found that they will add an oscillatory term to the Allan Variance of the active clock, degrading its frequency stability, and that under certain circumstances they may also shift the active clock's operating frequency. These two effects are discussed in detail, and the level of isolation required to render them negligible is established. Author

N91-25779*# Smithsonian Astrophysical Observatory, Cambridge, MA.
EFFECT OF THERMAL CYCLING ON STRESS IN METALLIC FILMS ON CERAMIC SUBSTRATES **c27**
Edward M. Mattison and Robert F. C. Vessot *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 301-306 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 11C

The hydrogen maser is the most stable frequency standard currently available for averaging intervals of hours to weeks. A major contributor to maser frequency variations is the maser's microwave resonant cavity: by means of the cavity pulling effect, a change in the cavity's resonance frequency produces a proportional change in the maser's output frequency. To minimize variations in the cavity's dimensions, and thus in its resonance frequency, maser cavities are often constructed of a low-expansivity glass-ceramic material coated on its surface with a conductive metallic film. It was previously shown that silver films like those used in SAO maser cavities develop tensile stress when cooled to room temperature after being fired onto the cavity, and that the stress in such films relaxes with time at a rate proportional to the level of stress. Stress relaxation in maser cavity coatings can alter the shape, and hence the resonance frequency, of the cavity, resulting in a slow variation in the maser's output frequency. The possibility was investigated of reversing the initial tensile stress by precooling the coated cavity material. It was hypothesized that cooling the material well below its normal working temperature and then warming it to its normal temperature would result in a lower tensile stress or even a compressive stress. Under such a condition stress relaxation, and thus any consequent frequency drifts, might be reduced or reversed. Author

N91-25780*# Bureau International des Poids et Mesures, Sevres (France).
SENSITIVITY TO THE EXTERNAL TEMPERATURE OF SOME GPS TIME RECEIVERS
Wlodzimierz W. Lewandowski and R. Tourde (Observatoire de Paris, France) *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 307-315 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

It has been assumed until recently that GPS time receiver units (recever+cables+antenna) have good stability and do not affect time transfer by more than 1 ns. Differences of a few nanoseconds sometimes function of the length and type of the antenna cable. In the most unfavorable case the sensitivity was 1.8 ns/C. Author

N91-25781*# ITT Corp., Nutley, NJ.
GPS BLOCK 2R TIME STANDARD ASSEMBLY (TSA) ARCHITECTURE
Anthony P. Baker *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 317-324 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

The underlying philosophy of the Global Positioning System (GPS) 2R Time Standard Assembly (TSA) architecture is to utilize two frequency sources, one fixed frequency reference source and one system frequency source, and to couple the system frequency source to the reference frequency source via a sample data loop. The system source is used to provide the basic clock frequency and timing for the space vehicle (SV) and it uses a voltage controlled crystal oscillator (VCXO) with high short term stability. The reference source is an atomic frequency standard (AFS) with high long term stability. The architecture can support any type of frequency standard. In the system design rubidium, cesium, and H2 masers outputting a canonical frequency were accommodated. The architecture is software intensive. All VCXO adjustments are digital and are calculated by a processor. They are applied to the VCXO via a digital to analog converter. Author

N91-25782*# Naval Research Lab., Washington, DC.
INTERIM RESULTS FROM THE CHARACTERIZATION TESTING OF THE ENGINEERING DEVELOPMENT (EDM) RUBIDIUM CLOCKS FOR SATELLITE APPLICATIONS
Edward D. Powers, Jr. and Fredrick Danzy *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 325-330 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

Some interim results from the environmental testing program to evaluate the Engineering Design Model (EDM) of the EG and G Spaceborne Rubidium Clock are presented. This effort is in support of the Global Positioning System (GPS) BLOCK IIR program and is intended to characterize the performance of EG and G design for BLOCK IIR satellite applications. Two EG and G EDM

units are currently under test at NRL's Clock Test Facility to measure the long-term frequency stability, drift, and frequency versus temperature characteristics. Author

N91-25783*# Observatoire Cantonal, Neuchatel (Switzerland).
ON THE LENGTH OF THE DRIFT REGION IN THE RAMSEY CAVITY
Pierre Thomann *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 331-337 Sponsored by Swiss Federal Office of Metrology, Wabern (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

The interaction of atoms in a beam with the microwave field in a separated field geometry such as a Ramsey cavity is generally described in terms of the three regions traversed successively by the atoms, namely two interaction regions of length (l) separated by a drift, or free precession, region of length L. For a monokinetic beam of velocity v, the linewidth of the central fringe in the Ramsey resonance pattern is usually expressed as delta omega equals pi v/L. A more detailed calculation shows, however, that the linewidth is equal to pi v/L asterisk, where the equivalent drift L asterisk is larger than L by an amount of the order of l/L. The correction depends on the field distribution in the interaction regions. Its origin lies in the fact that atomic precession is not limited to the field-free regions but also occurs in the interaction regions, where atomic coherence builds up or decreases continuously. Although the correction to the equivalent length of the drift region is small, it may be relevant to the evaluation of the second-order Doppler effect bias in primary cesium-beam standards to the extent that the atomic velocity is deduced from the lineshape and from the geometrical parameters of the cavity. It is shown that in current and projected standards with atoms of average thermal velocity, use of corrected dimensions may lead to a change of the calculated bias of the order of 10(exp -14), which is significant at the levels of accuracy considered nowadays. Author

N91-25784*# Quartz Research and Production Association, Gorky (USSR).
TIME AND FREQUENCY MEASURING METROLOGICAL EQUIPMENT IN THE USSR
Adolph A. Uljanov *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 339-343 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

The complex of the means of providing time and frequency traceability in the USSR includes the system of time and frequency standards of the National Time and Frequency Calibration Service, time and frequency transfer facilities and local time and frequency standards. Control on measurement correctness is performed by the All-Union State Standard calibration service. The hardware of most of the above-mentioned systems is provided by the instruments developed by our institute. A common scientific and technological approach allowed us to create a unified system of time-frequency equipment composed of widely used serial instruments, sets, automated systems and complexes. Primary frequency standards of different classes, time and frequency references and instruments are based on the unified system. CH1-70 hydrogen frequency standard and its CH1-70A, CH1-80 modifications are used in the group time and frequency standards. Measuring time and data processing techniques, and also instrumentation specifications on the results of 10-year operation are given. The existing system provides time-frequency measurements with 2 times 10(exp -13) plus or minus 1 times 10(exp -14) accuracy. Author

N91-25785*# Naval Research Lab., Washington, DC.
TWO-WAY TIME TRANSFER MODEM
Ivan J. Galysh and Paul Landis *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 345-348 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

The Naval Research Laboratory is developing a two-way time transfer modem that will work with very small aperture terminals (VSAT), commercial satellites, and an atomic clock. The two-way method was chosen because of its performance and insensitivity to the position of the receivers and satellites. Precision, stability, accuracy, and varsatility are the primary design considerations of this modem. The modem is designed to use many off the shelf components. Author

N91-25786*# National Research Council of Canada, Ottawa (Ontario). Inst. of National Measurement Standards.
[REPORT ON THE SPECIAL HYDROGEN MASER WORKSHOP]
Derek Morris *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 349-354 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 09C

This workshop was held as a discussion forum for hydrogen maser problems, particularly for those related to wall shift and wall relaxation effects. Brief summaries of the presentations made by the speakers together with some of the discussion that followed are given. These summaries were derived from tape recordings of the session and from notes. Author

N91-25787*# Bonneville Power Administration, Portland, OR. Telecommunications Systems Branch.
DELIVERY AND APPLICATION OF PRECISE TIMING FOR A TRAVELING WAVE POWERLINE FAULT LOCATOR SYSTEM **c33**
Michael A. Street *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 355-360 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 09C

The Bonneville Power Administration (BPA) has successfully operated an in-house developed powerline fault locator system since 1986. The BPA fault locator system consists of remotes installed at cardinal power transmission line system nodes and a central master which polls the remotes for traveling wave time-of-arrival data. A power line fault produces a fast rise-time traveling wave which emanates from the fault point and propagates throughout the power grid. The remotes time-tag the traveling wave leading edge as it passes through the power system cardinal substation nodes. A synchronizing pulse transmitted via the BPA analog microwave system on a wideband channel sychronizes the time-tagging counters in the remote units to a different accuracy of better than one microsecond. The remote units correct the raw time tags for synchronizing pulse propagation delay and return these corrected values to the fault locator master. The master then calculates the power system disturbance source using the collected time tags. The system design objective is a fault location accuracy of 300 meters. BPA's fault locator system operation, error producing phenomena, and method of distributing precise timing are described. Author

N91-25788*# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Electrical Engineering.
PRECISE SYNCHRONIZATION OF PHASOR MEASUREMENTS IN ELECTRIC POWER SYSTEMS **c33**
Arun G. Phadke *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 361-365 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 09C

Phasors representing positive sequence voltages and currents in a power network are in the most important parameters in several monitoring, control, and protection functions in interconnected electric power networks. Recent advances in computer relaying have led to very efficient and accurate phasor measurement systems. When the phasors to be measured are separated by hundreds of miles, it becomes necessary to synchronize the measurement processes, so that a consistent description of the state of the power system can be established. Global Positioning

System (GPS) transmissions offer an ideal source for synchronization of phasor measurements. The concept and implementation of this technique are described. Several uses of synchronized phasor measurements are also described. Among these are improved state estimation algorithms, state estimator enhancements, dynamic state estimates, improved control techniques, and improved protection concepts. Author

N91-25789*# Nippon Telegraph and Telephone Public Corp., Yokosuka (Japan). Transmission Systems Labs.
TIME CONCURRENCY/PHASE-TIME SYNCHRONIZATION IN DIGITAL COMMUNICATIONS NETWORKS c32
Masami Kihara and Atsushi Imaoka *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 367-374 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 17B

Digital communications networks have the intrinsic capability of time synchronization which makes it possible for networks to supply time signals to some applications and services. A practical estimation method for the time concurrency on terrestrial networks is presented. By using this method, time concurrency capability of the Nippon Telegraph and Telephone Corporation (NTT) digital communications network is estimated to be better than 300 ns rms at an advanced level, and 20 ns rms at final level. Author

N91-25790*# Cable and Wireless PLC, London (England).
THE CABLE AND WIRELESS APPROACH TO NETWORK SYNCHRONIZATION c32
Robert D. Calvert *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 375-382 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 17B

The philosophy adopted by Cable and Wireless for the synchronization of its world-wide network is presented. The architectures of some clock systems already deployed and how network synchronization had been implemented at selected locations are discussed. This includes some innovative designs as the network spans both first and third world countries with a combination of North Amercan and European hierarchy equipment. Different parts of the global network are linked together by a combination of terrestrial microwave, submarine cable and satellite technology. The impact of synchronization on Intelsat Intermediate Data Rate (IDR) operation and the restoration of submarine cable systems are addressed. Author

N91-25791*# International Telecommunications Satellite Organization, Washington, DC.
INTERNATIONAL TWO-WAY SATELLITE TIME TRANSFERS USING INTELSAT SPACE SEGMENT AND SMALL EARTH STATIONS
Lester B. Veenstra *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 383-399 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

The satellite operated by the International Telecommunications Satellite Organization (INTELSAT) provides new and unique capabilities for the coordinates of international time scales on a world wide basis using the two-way technique. A network of coordinated clocks using small earth stations collocated with the scales is possible. Antennas as small as 1.8 m at K-band and 3 m at C-band transmitting powers of less than 1 W will provide signals with time jitters of less than 1 ns existing spread spectrum modems. One way time broadcasting is also possible, under the INTELSAT INTELNET system, possibly using existing international data distribution (press and financial) systems that are already operating spread spectrum systems. The technical details of the satellite and requirements on satellite earth stations are given. The resources required for a regular operational international time transfer service are analyzed with respect to the existing international digital service offerings of the INTELSAT Business Service (IBS) and INTELNET. Coverage areas, typical link budgets, and a summary of previous domestic and international work using this technique are provided. Administrative procedures for gaining access to the space segment are outlined. Contact information for local INTELSAT signatories is listed. Author

N91-25792*# British Broadcasting Corp., London (England).
THE BBC NETWORK RADIO TIME AND FREQUENCY STANDARD AND ITS ROLE IN THE PROVISION OF THE GREENWICH TIME SIGNAL
Jim J. McIlroy *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 401-408 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

The British Broadcasting Corporation (BBC) has broadcast the Greenwich Time Signal (GTS) on its networks since 1924. Up to February 1990 this signal was generated by the Royal Greenwich Observatory (RGO) in England. The BBC was informed that the RGO was moving its location to Cambridge and might not be able to continue to provide the Greenwich Time Service. The BBC in its role of a public service broadcaster believed that a long tradition of providing a time signal to its listeners should be upheld, and as such decided to seek alternative methods of provision. In parallel with this activity, an in-house requirement arose to re-engineer time switch equipment and provide new facilities for digital audio projects. As both requirements have a common engineering core, a decision was taken to design and procure a Time and Frequency Standard that could generate the Greenwich Time Signal to the same specification adhered to by the RGO, and provide additional time and frequency facilities. The concept of time and time/frequency dissemination as used in a broadcast network is discussed, as well as the details of an engineering solution to the requirements of BBC Network Radio. Author

N91-25793*# National Inst. of Standards and Technology, Boulder, CO. Time and Frequency Div.
SYNCHRONIZING COMPUTER CLOCKS USING A LOCAL AREA NETWORK
Judah Levine *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 409-417 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

Researchers completed the first tests of a method to synchronize the clocks of networked computers to the National Institute of Standards and Technology (NIST) time scale. The method uses a server computer to disseminate the time to other clients on the same local-area network. The server is synchronized to NIST using the ACTS protocol over a dial-up telephone line. The software in both the server and the parameters of this model are used to adjust the time of the local clock and the interval between calibration requests in a statistically optimum way. The algorithm maximizes the time between calibrations while at the same time keeping the time of the local clock correct within a specific tolerance. The method can be extended to synchronize computers linked over wide-area networks, and an experiment to test the performance of the algorithms over such networks is being planned. Author

N91-25794*# Laboratoire de l'Horloge Atomique, Orsay (France).
PHYSICAL ORIGIN OF THE FREQUENCY SHIFTS IN CESIUM BEAM FREQUENCY STANDARDS: RELATED ENVIRONMENTAL SENSITIVITY
Claude Audoin, N. Dimarcq, V. Giordano, and J. Viennet *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 419-439 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

When observed in a cesium beam frequency standard, the hyperfine transition frequency of the atoms differs slightly from the invariant transition frequency of the unperturbed atoms at rest. The various physical and technical origins of the frequency offsets

are stated. They relate to fundamental physical effects, to the method of probing the atomic resonance and to the frequency control of the slaved oscillator. The variation of the frequency offsets under a change of the value of the internal operating characteristics is considered. The sensitivity to a change of the magnetic induction, the microwave power, and the temperature is given. A comparison is made of the sensitivity of cesium beam frequency standards of the commercially available type, making use of magnetic state selection, and of devices under study, in which the state preparation and detection is accomplished optically. The pathways between the external stimuli and the physical origin of the frequency offsets are specified. Author

N91-25795*# Edgerton, Germeshausen and Grier, Inc., Salem, MA.

THE PHYSICS OF THE ENVIRONMENTAL SENSITIVITY OF RUBIDIUM GAS CELL ATOMIC FREQUENCY STANDARDS

William J. Riley *In* JPL, The 22nd Annual Precise Time and Time Interval (PITI) Applications and Planning Meeting May 1990 p 441-452 (For primary document see N91-25755 17-70)

Avail: NTIS HC/MF A99 CSCL 20C

Environmental sensitivity is often the most significant limitation to the practical stability of rubidium frequency standards (RFS). For example, temperature sensitivity can cause a rapid frequency change of several parts in 10(exp 10) for a tactical RFS that has an aging of only 1 times 10(exp -11)/month. Other important environmental factors are barometric pressure, vibration, magnetic field, and nuclear radiation. The physical mechanisms that lie behind these environmental sensitivities are considered. These physical mechanisms are related to the performance of actual rubidium frequency standards. For the user of these devices, a better knowledge of the causes for Rb clock instability will aid in their testing and proper application. For the time frequency specialist, a review of these factors may prove useful toward improving RFS design. Some of the RFS environmental sensitivities are due to simple physical mechanisms like the effect of dc magnetic field on the Rb hyperfine resonance frequency. For these, an analysis can be based on physical principles and straightforward design factors. Other environment factors, like temperature sensitivity, are more complex combinations of many effects, both physical and practical, and the analysis often takes the form of an error budget with large unit-to-unit variations. Today's rubidium frequency standards span a wide performance range from small, inexpensive units with pp 10(exp 10) error budgets to larger, higher performance versions offering pp 10(exp 10) stabilities. For both extremes, however, environmental sensitivity can be the most significant performance limitation. Why this is the case and how to make improvements are discussed. Author

N91-25796*# Smithsonian Astrophysical Observatory, Cambridge, MA.

PHYSICS OF SYSTEMATIC FREQUENCY VARIATIONS IN HYDROGEN MASERS **c36**

Edward M. Mattison *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 453-464 (For primary document see N91-25755 17-70)

Avail: NTIS HC/MF A99 CSCL 20E

The frequency stability of hydrogen masers for intervals longer that 10(exp 4) seconds is limited at present by systematic processes. Researchers discuss the physics of frequency-determining mechanisms internal to the maser that are susceptible to systematic variations, and the connections between these internal mechanisms and external environmental factors. Based upon estimates of the magnitudes of systematic effects, they find that the primary internal mechanisms currently limiting long-term maser frequency stability are cavity pulling, at the level parts in 10(exp 15) per day, and wall shift variations, at the level of parts in 10(exp 16) to parts in 10(exp 15) per day. They discuss strategies for reducing systematic frequency variations. Author

N91-25797*# National Inst. of Standards and Technology, Boulder, CO. Time and Frequency Div.

ENVIRONMENTAL SENSITIVITIES OF QUARTZ CRYSTAL OSCILLATORS **c76**

Fred L. Walls *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 465-486 (For primary document see N91-25755 17-70)

Avail: NTIS HC/MF A99 CSCL 20L

The frequency, amplitude, and noise of the output signal of a quartz crystal controlled oscillator is affected by a large number of environmental effects. The physical basis for the sensitivity of precision oscillators to temperature, humidity, pressure, vibration, magnetic field, electric field, load, and radiation is discussed. The sensitivity of crystal oscillators to radiation is a very complex topic and poorly understood. Therefore only a few general results are mentioned. The sensitivity to most external influences often varies significantly from one oscillator type to another and from one unit of given type to another. For a given unit, the sensitivity to one parameter often depends on the value of other parameters and history. Author

N91-25798*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

LOCAL OSCILLATOR INDUCED DEGRADATION OF MEDIUM-TERM STABILITY IN PASSIVE ATOMIC FREQUENCY STANDARDS

G. John Dick, John D. Prestage, Charles A. Greenhall, and Lute Maleki *In its* The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 487-508 (For primary document see N91-25755 17-70)

Avail: NTIS HC/MF A99 CSCL 20C

As the performance of passive atomic frequency standards improves, a new limitation is encountered due to frequency fluctuations in an ancillary local oscillator (L.O.). The effect is due to time variation in the gain of the feedback which compensates L.O. frequency fluctuations. The high performance promised by new microwave and optical trapped ion standards may be severely compromised by this effect. Researchers present an analysis of this performance limitation for the case of sequentially interrogated standards. The time dependence of the sensitivity of the interrogation process to L.O. frequency fluctuations is evaluated for single-pulse and double-pulse Ramsey RF interrogation and for amplitude modulated pulses. The effect of these various time dependencies on performance of the standard is calculated for an L.O. with frequency fluctuations showing a typical 1/f spectral density. A limiting 1/sq. root gamma dependent deviation of frequency fluctuations is calculated as a function of pulse lengths, dead time, and pulse overlap. Researchers also present conceptual and hardware-oriented solutions to this problem which achieve a much more nearly constant sensitivity to L.O. fluctuations. Solutions involve use of double-pulse interrogation; alternate interrogation of multiple traps so that the dead time of one trap can be covered by operation of the other; and the use of double-pulse interrogation for two traps, so that during the time of the RF pulses, the increasing sensitivity of one trap tends to compensate for the decreasing sensitivity of the other. A solution making use of amplified-modulated pulses is also presented which shows nominally zero time variation. Author

N91-25799*# Quartz Research and Production Association, Gorky (USSR).

PERFORMANCE OF SOVIET AND US HYDROGEN MASERS **c36**

Adolph A. Uljanov, Nikolai A. Demidov, Edward M. Mattison, Robert F. C. Vessot, David W. Allan, and Gernot M. R. Winkler (Naval Observatory, Washington, DC.) *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 509-523 (For primary document see N91-25755 17-70)

Avail: NTIS HC/MF A99 CSCL 20E

The frequencies of Soviet- and U.S.-built hydrogen masers located at the Smithsonian Astrophysical Observatory and at the United States Naval Observatory (USNO) were compared with each

other and, via Global Positioning System (GPS) common-view measurements, with three primary frequency-reference scales. The best masers were found to have fractional frequency stabilities as low as 6 times 10(exp -16) for averaging times of approximately 10(exp 4) s. Members of the USNO maser ensemble provided frequency prediction better than 1 times 10(exp 14) for periods up to a few weeks. The frequency residuals of these masers, after removal of frequency drift and rate of change of drift, had stabilities of a few parts in 10(exp -15), with serveral masers achieving residual stabilities well below 1 times 10(exp -15) for intervals from 10(exp 5)s to 2 times 10(exp 6)s. The fractional frequency drifts of the 13 masers studied, relative to the primary reference standards, ranged from -0.2 times 10(exp -15)/day to +9.6 times 10(exp -15)/day. Author

N91-25800*# Leningrad Scientific Research Radiotechnical Inst. (USSR).
THE NATIONAL- AND INTERNATIONAL-WIDE PROSPECTS OF FUTURE IMPROVEMENTS OF POSITION LOCATION AND TIME SYNCHRONIZATION SYSTEMS AND AIDS
Yuri G. Gouzhva, Boris N. Balyasnikov, Vladimir V. Korniyenko, Irina G. Pushkina, Valentin S. Shebshayevich, Vladimir I. Denisov, and Alexander P. Reutov (Ministry of Radio Industry,, USSR) *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 525-528 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

The concept being designed by the Leningrad Scientific Research Radio Technical Institute (LSRRI) of united positioning and timing service on the basis of the utilization of long-range and global radionavigation and common time systems and aids for different users is described. The estimate of its utilization on the national as well as on international scale is given. Author

N91-25801*# Aerospace Corp., Los Angeles, CA.
GPS COMPOSITE CLOCK SOFTWARE PERFORMANCE
Arthur L. Satin, W. A. Feess, Henry F. Fliegel, and C. H. Yinger *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 529-545 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

Computer software for ensembling all the space vehicle (SV) and ground clocks of the Global Positioning Systems (GPS) was implemented at the Master Control Station (MCS) on 17 June 1990. Improved GPS time stability and steering control are predicted. The perceptions of both Air Force and outside users are assessed. Current performance is compared with theoretical predictions. Author

N91-25802*# Bureau International des Poids et Mesures, Sevres (France).
THE USE OF PRECISE EPHEMERIDES, IONOSPHERIC DATA, AND CORRECTED ANTENNA COORDINATES IN A LONG-DISTANCE GPS TIME TRANSFER
Wlodzimierz W. Lewandowski, Gerard Petit, Claudine Thomas, and Marc A. Weiss (National Inst. of Standards and Technology, Boulder, CO.) *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 547-558 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

Over intercontinental distances, the accuracy of The Global Positioning System (GPS) time transfers ranges from 10 to 20 ns. The principal error sources are the broadcast ionospheric model, the broadcast ephemerides and the local antenna coordinates. For the first time, the three major error sources for GPS time transfer can be reduced simultaneously for a particular time link. Ionospheric measurement systems of the National Institute of Standards and Technology (NIST) type are now operating on a regular basis at the National Institute of Standards and Technology in Boulder and at the Paris Observatory in Paris. Broadcast ephemerides are currently recorded for time-transfer tracks between these sites, this being necessary for using precise ephemerides. At last, corrected local GPS antenna coordinates are now introduced in GPS receivers at both sites. Shown here is the improvement in precision for this long-distance time comparison resulting from the reduction of these three error sources. Author

N91-25803*# AUSTRON, Inc., Austin, TX.
GPS/LORAN-C INTEROPERABILITY FOR TIME AND FREQUENCY APPLICATIONS: A SURVEY OF THE TIMES OF ARRIVAL OF LORAN-C TRANSMISSIONS VIA GPS COMMON MODE/COMMON VIEW SATELLITE OBSERVATIONS c04
Bruce Penrod, Richard Funderburk, and Peter Dana *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 559-574 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 17G

The results from this survey clearly indicate that the Global Positioning System (GPS) time transfer capability is superior to that of the Loran-C system for absolute timing accuracy, and that even with the most careful calibration of the Loran-C receiver delay and propagation path, inexplicable time of arrival (TOA) biases remain which are larger than the variations across all of the transmitters. Much more data covering years would be needed to show that these biases were stable enough to be removed with a one time site calibration. The synchronization of the transmissions is excellent, all showing low parts in 10(exp 13) offsets versus the United States Naval Observatory (USNO) master clock. With the exception of the Searchlight transmitter, all of the transmissions exhibit timing stabilities over the entire period of less than 300 ns RMS which is at the observed levels of GPS under selective availability (SA). The Loran-C phase instabilities take place over a much greater time interval than those being forced onto the GPS signals under SA, providing for better medium to short term frequency stability. Data show that all but the most distant transmitters offer better than three parts in 10(exp 11) stability at this averaging time. It is in the frequency control area where GPS/Loran-C interoperation will offer some synergistic advantages over GPS alone under SA. Author

N91-25804*# Observatoire de la Cote d'Azur, Nice (France).
LASSO, TWO-WAY, AND GPS TIME COMPARISONS: A (VERY) PRELIMINARY STATUS REPORT
Christian J. L. Veillet, D. Feraudy, J. M. Torre, J. F. Mangin, P. Grudler, Francoise S. Baumont, Jean C. Gaignebet, J. L. Hatat, Wayne Hanson, and A. Clements (National Inst. of Standards and Technology, Boulder, CO.) et al *In* JPL, The 22nd Annual Precuse Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 575-582 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20C

The first results are presented on the time transfer experiments between TUG (Graz, Austria) and OCA (Grasse, France) using common view Global Positioning System (GPS) and two-way stations at both sites. The present data, providing arms of the clock offsets of 2 to 3 nanoseconds for a three month period, have to be further analyzed before any conclusions on the respective precision and accuracy of these techniques can be drawn. Two years after its start, the Laser Synchronization from Stationary Orbit (LASSO) experiment is finally giving its first results at TUG and OCA. The first analysis of three common sessions permitted researchers to conclude that the LASSO package on board Meteosat P2 is working satisfactorily, and that time transfer using this method should provide clock offsets at better than 1 nanosecond precision, and clock rates at better than 10(exp -12) s/s in a 5 to 10 minutes session. A new method for extracting this information from the raw data sent by LASSO should enhance the performances of this experiment, exploiting the stability of the on-board oscillator. Author

N91-25805*# Politecnico di Torino (Italy).
RECENT DEVELOPMENTS OF LORAN-C IN EUROPE c04
Sigfrido Leschiutta and Enrico Rubiola *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 583-597 (For primary document see

N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 17G

Even if recent developments, both technical and political, are affecting the satellite Global Positioning System (GPS) and GLONASS navigation systems, alone, in conjunction, or with a possible civilian overlay via INMARSAT or other satellites, time has proven that Loran-C can still be a viable solution for many problems. The aims here are twofold, to present a panorama of the most recent developments in the world and mostly in Europe, and to consider some technical aspects of two problems regarding the Mediterranean Sea chain. This chain is based on four stations, two in Italy, one in Spain and one in Turkey. The fate of the station in Turkey is known, in the sense that this station will not operate when the U.S. support will cease; the future of the Spanish station is not yet known, while Italy has expressed its intention to operate the two remaining stations. Consequently two problems need to be solved to assure at least the coverage of Italy and of the eastern Mediterranean Sea. Author

N91-25806*# Observatoire Cantonal, Neuchatel (Switzerland).
ON THE LINE Q DEGRADATION IN HYDROGEN MASERS
c36

L. G. Bernier, Giovanni Busca, and Hartmut S. Schweda *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 599-606 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20E

In hydrogen masers, the atomic resonance quality factor is largely determined by the properties of the Teflon coating on the quartz storage bulb. Normally a good Teflon coating will last many years. On the other hand, there may be a relatively fast degradation of the quality factor if the Teflon coating is bad. A series of observations and measurements performed on an hydrogen maser that had successively a bad and a good Teflon coating are discussed. Author

N91-25807*# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Engineering Science and Mechanics.
A STUDY OF THE RESPONSE OF NONLINEAR SPRINGS Final Report, 25 Aug. 1988 - 15 Aug. 1990
M. W. Hyer, T. W. Knott, and E. R. Johnson Jul. 1991 126 p (Contract NCC1-130)
(NASA-CR-188602; NAS 1.26:188602; VPI-E-91-09) Avail: NTIS HC/MF A07 CSCL 20C

The various phases to developing a methodology for studying the response of a spring-reinforced arch subjected to a point load are discussed. The arch is simply supported at its ends with both the spring and the point load assumed to be at midspan. The spring is present to off-set the typical snap through behavior normally associated with arches, and to provide a structure that responds with constant resistance over a finite displacement. The various phases discussed consist of the following: (1) development of the closed-form solution for the shallow arch case; (2) development of a finite difference analysis to study (shallow) arches; and (3) development of a finite element analysis for studying more general shallow and nonshallow arches. The two numerical analyses rely on a continuation scheme to move the solution past limit points, and to move onto bifurcated paths, both characteristics being common to the arch problem. An eigenvalue method is used for a continuation scheme. The finite difference analysis is based on a mixed formulation (force and displacement variables) of the governing equations. The governing equations for the mixed formulation are in first order form, making the finite difference implementation convenient. However, the mixed formulation is not well-suited for the eigenvalue continuation scheme. This provided the motivation for the displacement based finite element analysis. Both the finite difference and the finite element analyses are compared with the closed form shallow arch solution. Agreement is excellent, except for the potential problems with the finite difference analysis and the continuation scheme. Agreement between the finite element analysis and another investigator's numerical analysis for deep arches is also good. Author

N91-25808# Joint Publications Research Service, Arlington, VA.
JPRS REPORT: SCIENCE AND TECHNOLOGY. USSR: PHYSICS AND MATHEMATICS
7 Mar. 1991 32 p Transl. into ENGLISH from various Russian articles
(JPRS-UPM-91-003) Avail: NTIS HC/MF A03

Abstracts of research on acoustics, crystals, laser glasses, semiconductors, fluid dynamics, lasers, nuclear physics, spectroscopy, plasma physics, superconductivity, numerical analysis, algorithms, and differential equations are given. Author

N91-25809# Joint Publications Research Service, Arlington, VA.
JPRS REPORT: SCIENCE AND TECHNOLOGY. USSR: PHYSICS AND MATHEMATICS
17 Jan. 1991 31 p Transl. into ENGLISH from various Russian articles
(JPRS-UPM-91-002) Avail: NTIS HC/MF A03

Abstracts of research in acoustics, fluid dynamics, lasers, nuclear physics, spectroscopy, plasma physics, superconductivity, theoretical physics, and differential equations are given. Author

N91-25810# Joint Publications Research Service, Arlington, VA.
JPRS REPORT: SCIENCE AND TECHNOLOGY. USSR: PHYSICS AND MATHEMATICS
9 Jan. 1991 46 p Transl. into ENGLISH from various Russian articles
(JPRS-UPM-91-001) Avail: NTIS HC/MF A03

Abstracts of research in acoustics, crystals, laser glasses, semiconductors, fluid dynamics, lasers, nuclear physics, spectroscopy, plasma physics, superconductivity, theoretical physics, differential equations, and group theory are given.
Author

N91-25811# Joint Publications Research Service, Arlington, VA.
JPRS REPORT: SCIENCE AND TECHNOLOGY. USSR: PHYSICS AND MATHEMATICS
28 Nov. 1990 43 p Transl. into ENGLISH from various Russian articles
(JPRS-UPM-90-005) Avail: NTIS HC/MF A03

Abstracts of research in acoustics, crystals, lasers glasses, semiconductors, fluid dynamics, lasers, nuclear physics, spectroscopy, plasma physics, superconductivity, and probability are given. Author

N91-25812# Technische Univ., Delft (Netherlands).
ESTIMATION OF MACRO VELOCITY MODELS BY WAVE FIELD EXTRAPOLATION Ph.D. Thesis
Hendricus Lambertus Cox 1991 173 p
(ISBN-90-9003926-0; ETN-91-99433) Copyright Avail: NTIS HC/MF A08

A method to estimate accurate macro velocity models for prediction of traveltimes of seismic waves in the earth's subsurface is developed. The sensitivity of prestack migration is used to estimate the model and since model errors are expressed in the quality of the migration result, the migration process itself can be used to determine these errors. Using an initial model, shot records are downward extrapolated to grid points (depth points) in the subsurface. The extrapolated data can be reordered into so called common depth point (CDP) gathers, image gathers and focus panels. The deviation from horizontal alignment is used to quantify the errors in the model and to apply update corrections accordingly. The analysis can be done before or after stacking over all shot records (CDP stacking). the previously mentioned focus panels are generated by CDP stacking. The alignment analysis reduces then to a simple focusing analysis. The examples discussed show that horizontal alignment gives accurate macro velocity models for prestack depth migration. Focus panels can be difficult to interpret in complicated situations, where it is impossible to converge to the correct solution with focus panels only. The process should be guided by macrogeologic models of the area. In complicated situations, a layer stripping strategy is preferred.
ESA

N91-25813# Lawrence Livermore National Lab., CA.
EMITTANCE MEASUREMENT IN A MAGNETIC FIELD
J. K. Boyd 15 Apr. 1991 5 p Presented at the 1991 Institute of Electrical and Electronics Engineers (IEEE) Particle Accelerator Conference (PAC), San Francisco, 6-9 May 1991
(Contract W-7405-eng-48)
(DE91-011540; UCRL-JC-105560; CONF-910505-20) Avail: NTIS HC/MF A01

Emittance can be measured by intercepting an electron beam on a range thick plate and then observing the expansion of beamlets transmitted through small holes. The hole size is selected to minimize space charge effects. In the presence of a magnetic field the beamlets have a spiral trajectory and the usual field free formulation must be modified. To interpret emittance in the presence of a magnetic field an envelope equation is derived in the appropriate rotating frame. DOE

N91-25814# Lawrence Livermore National Lab., CA.
A DIFFERENTIAL EQUATION APPROACH TO MINOR LOOPS IN THE JILES-ATHERTON HYSTERESIS MODEL
K. H. Carpenter (Kansas State Univ., Manhattan.) Apr. 1991 8 p
(Contract W-7405-eng-48)
(DE91-011448; UCRL-CR-106986) Avail: NTIS HC/MF A02

Jiles and Atherton, in a series of papers, present physically based differential equations for magnetization in ferromagnetic materials. However, if one directly solves their differential equations, the minor loops obtained can have negative slopes, which is a non-physical behavior. Only one of their papers gives a method for obtaining minor loops, and the method does not use a differential equation, but requires a priori knowledge of the loop turning points in order to obtain a scale factor and offset which allow a portion of a major loop to serve as a portion of a minor one. In this paper the reason for the failure of the original differential equations to yield physical minor loops is explained, and a modified solution for minor loops is presented which retains the features of Jiles and Atherton's minor loops, but only requires knowledge of the initial point on each portion of the loop to obtain the solution. This yields a general differential equation formulation for the Jiles-Atherton theory that can be used with circuit simulations having arbitrary excitations and initial conditions for ferromagnetic components. DOE

71 ACOUSTICS

Includes sound generation, transmission and attenuation. For noise pollution see *45 Environmental Pollution.*

N91-25815# National Aerospace Lab., Tokyo (Japan).
THE REDUCTION OF CAVITY NOISE AT SUBSONIC SPEEDS
Katsumi Takeda, Hideo Nishiwaki, and Shouichi Fujii Sep. 1990 11 p In JAPANESE; ENGLISH summary
(NAL-TR-1081) Avail: NTIS HC/MF A03

It is generally recognized that airframe noise becomes a significant contributor to overall aircraft noise under landing conditions. Airframe noise is considered to be the sound radiated aerodynamically as a result of complex interplay between local flows and configurations that intrude or are recessed or deployed over the lifting surfaces and fuselage. The scale model acoustic testing of landing gears revealed that the cavity noise was predominant in sound sources of landing device. A study performed to determine the sound generation mechanism and to reduce the sound level of the cavity noise is presented. It is observed that an array of fins attached on the leading edge of the cavity offered a reduction of 7 to 8 dB in the sound pressure levels. Author

N91-25816# Los Alamos National Lab., NM.
EVALUATION OF NASHUA/NASTRAN PERFORMANCE AT LOS ALAMOS
J. L. Fales Apr. 1991 28 p
(Contract W-7405-eng-36)
(DE91-011196; LA-12075-MS) Avail: NTIS HC/MF A03

To improve the feasibility of using finite element methods for complex, structural acoustics calculations, a study was launched to identify possible efficiency enhancements to existing computer codes. In particular, the codes which form the NASHUA/NASTRAN procedure were investigated. This study concentrated on straight-forward improvements rather than substantial code changes. Means for improving the performance of the NASHUA/NASTRAN procedure at Los Alamos were investigated and implemented. As a result, performance increases of two to five times were realized. In particular, the use of memory and other site-specific factors are discussed. On the basis of these findings, guidelines are provided for the efficient use of this procedure at the Los Alamos National Laboratory. DOE

N91-25817*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
TUNED OPTIMIZATION OF EXTENDED REACTING ACOUSTIC LINERS
Kenneth J. Baumeister 1991 9 p Presented at the 1991 Winter Annual Meeting of ASME, Atlanta, GA, 1-6 Dec. 1991
(NASA-TM-104431; E-6265; NAS 1.15:104431) Avail: NTIS HC/MF A02 CSCL 20A

A finite element Galerkin formulation was employed to study the optimum attenuation and reflection characteristics of acoustic waves propagating in tw0 dimensional straight ducts with extended reacting absorbing walls without a mean flow. The reflection and transmission of acoustic energy at the entrance and the exit of the duct were determined by coupling the finite element solutions in the absorbing portion of the duct to the eigenfunctions of an infinite, uniform, hard wall duct. In the frequency range where the duct height and acoustic wave length are nearly equal, power attenuation contours were examined to determine conditions for minimizing acoustic transmission through the duct. The extended reacting liners were found to significantly minimize the reflective characteristics of the duct rather than to increase absorption in the liner. Thus, extended reacting wall liner properties can be theoretically chosen to yield large impedance mismatches in an open straight duct. Author

N91-25818# Office of Naval Research European Office, FPO New York, NY.
ACOUSTICS RESEARCH IN EUROPE AND THE SOVIET UNION
Dec. 1990 64 p
(PB91-159830; ESNIB-90-0) Avail: NTIS HC/MF A04 CSCL 20A

Observations are provided on recent European and Soviet developments in the fields of structural acoustics, underwater acoustics, and physical acoustics. European activity in these areas range from architectural applications to active noise cancellation in automobiles and aircraft, and underwater sound propagation and signal processing. Applications of active control to engineering systems, the Heard Island Acoustic Tomography Experiment, the dynamics of marine vehicles and structures in waves, natural sources of noise in the ocean, and noise control engineering are among the topics covered. Author

72 ATOMIC AND MOLECULAR PHYSICS

Includes atomic structure, electron properties, and molecular spectra.

N91-25819*# San Francisco Univ., CA. Physics Research Lab.
RADIATION EXPERIMENTS ON COSMOS 2044: K-7-41, PARTS A, B, C, D, E Final Report
A. L. Frank, E. V. Benton, E. R. Benton, V. E. Dudkin, and A. M. Marenny (Institute of Biomedical Problems, Moscow, USSR) 4 Sep. 1990 52 p
(Contract NCC2-521; NAG9-235)
(NASA-CR-188540; NAS 1.26:188540; USF-TR-76) Avail: NTIS HC/MF A04 CSCL 20H

The Cosmos 2044 biosatellite mission offered the opportunity

for radiation measurements under conditions which are seldom available (an inclination of 82.3 deg and attitude of 294 x 216 km). Measurements were made on the outside of the spacecraft under near-zero shielding conditions. Also, this mission was the first in which active temperature recorders (the ATR-4) were flown to record the temperature profiles of detector stacks. Measurements made on this mission provide a comparison and test for modeling of depth doses and LET spectra for orbital parameters previously unavailable. Tissue absorbed doses from 3480 rad (252 rad/d) down to 0.115 rad (8.33 mrad/d) were measured at different depths (0.0146 and 3.20 g/sq cm, respectively) with averaged TLD readings. The LET spectra yielded maximum and minimum values of integral flux of 27.3 x 10(exp -4) and 3.05 x 10(exp -4)/sq cm/s/sr, of dose rate of 7.01 and 1.20 mrad/d, and of dose equivalent rate of 53.8 and 11.6 mrem/d, for LET(sub infinity)-H2O is greater than or equal to 4 keV/micron. Neutron measurements yielded 0.018 mrem/d in the thermal region, 0.25 mrem/d in the resonance region and 3.3 mrem/d in the high energy region. The TLD depth dose and LET spectra were compared with calculations from the modeling codes. The agreement is good but some further refinements are in order. In comparing measurements on Cosmos 2044 with those from previous Cosmos missions (orbital inclinations of 62.8 deg) there is a greater spread (maximum to minimum) in depth doses and an increased contribution from GCRs, and higher LET particles, in the heavy particle fluxes. Author

N91-25820# Japan Atomic Energy Research Inst., Tokai. Nuclear Data Committee.
A NUCLEAR CROSS SECTION CALCULATION SYSTEM WITH SIMPLIFIED INPUT-FORMAT
Nobuhiro Yamamuro Feb. 1990 64 p
(DE90-008002; JAERI-M-90-006; NEANDC(J)-146/U; INDC(JPN)-133/L) Avail: NTIS HC/MF A04

A Nuclear Cross Section Calculation System with Simplified Input Format, Version 2 (SINCROS-2) was developed by improving the functions of the program in SINCROS-1, and preparing some process codes for the cross section applications. There is the option of optical model potentials for neutron and proton, and the capture cross section normalization to the experiment and the width fluctuation correction to compound nuclear cross section become possible. The method recommended for nuclear cross section calculation is described. This system is used to estimate the cross sections of nuclei for which the experimental data do not exist. DOE

N91-25821# Japan Atomic Energy Research Inst., Tokyo.
EVALUATION OF NEUTRON NUCLEAR DATA FOR He-3 AND He-4
Keiichi Shibata Feb. 1990 34 p
(DE90-008017; JAERI-M-90-024; NEANDC(J)-148/U; INDC(JPN)-135/L) Avail: NTIS HC/MF A03

Neutron-induced cross sections of He-3 and He-4 were evaluated for JENDL-3 in the energy range from 10(exp -5) eV to 20 MeV. Evaluated quantities are the total and elastic scattering cross sections of He-4 and the total, elastic scattering, (n,p) and (n,d) reaction cross sections of He-3. The total and elastic scattering cross sections of He-4 were analyzed with the R-matrix theory in the overall energy region. In the He-3 evaluation, the R-matrix calculation was performed below 1 MeV by considering the total, elastic scattering and (n,p) reaction cross sections, and above 1 MeV the evaluation was based on available experimental data. The evaluated data were compiled in the ENDF-5 format. DOE

N91-25822# Japan Atomic Energy Research Inst., Tokai.
EVALUATION OF NEUTRON NUCLEAR DATA FOR O-16
Keiichi Shibata, Satoshi Chiba, Tetsuo Asami, and Toru Murata (Toshiba Corp., Tokyo, Japan) Feb. 1990 32 p
(DE90-008105; JAERI-M-90-012; NEANDC(J)-147/U; INDC(JPN)-134/L) Avail: NTIS HC/MF A03

Neutron nuclear data of O-16 were evaluated for JENDL-3 in the energy range from 10(exp -5) eV to 20 MeV. Evaluated quantities are the total, elastic, and inelastic scattering, (n,2n), (n gamma), (n,p), (n,d), (n alpha), (n, np) and (n, n alpha) reaction cross sections and the angular and energy distributions of emitted neutrons and gamma rays. The total cross section below 3 MeV was calculated on the basis of the R matrix theory. The inelastic scattering, (n,np) and (n,n alpha) reaction cross sections were obtained from the statistical model calculation. The gamma ray production cross section was also calculated with the statistical model. DOE

N91-25823# North Carolina Univ., Chapel Hill.
PEPICO STUDIES OF ION DISSOCIATIONS: THE STRUCTURE AND HEATS OF FORMATION OF IONS, MOLECULES, AND FREE RADICALS
T. Baer 1990 14 p
(Contract DE-FG05-88ER-13950)
(DE91-010742; DOE/ER-13950/3) Avail: NTIS HC/MF A03

A new photoelectron photoion coincidence (PEPICO) apparatus that incorporates a supersonic molecular beam and refocusing of the vacuum UV radiation with a grazing incidence mirror was constructed and tested. Because the sample in a molecular beam can be cooled to very low temperatures it is possible to study with high energy resolution large molecules that have broad room temperature internal energy distributions. The apparatus was tested by investigating the breakdown diagrams of isobutane and pentane. These studies demonstrate that even mild expansion conditions (300 Torr) are sufficient to reduce the average internal energy of these molecules from ca 120 MeV to less than 5 MeV. The apparatus was also used to investigate the dissociation rates of energy selected ethylchloride ions. RRKM calculations that incorporate tunneling through an isomerization barrier provide an excellent fit for the experimental rates. Finally, cluster studies were carried out and a new method for determining whether a particular cluster ion was produced by direct ionization, or was itself the dissociation product from a higher order cluster, was developed. In addition to the molecular beam studies, another PEPICO apparatus was modified to permit the study of free radicals. DOE

N91-25824# Los Alamos National Lab., NM.
SPACETIME NONLOCALITY AND RETARDATION IN RELATIVISTIC HEAVY-ION COLLISIONS
B. W. Bush, J. R. Nix, and A. J. Sierk 1991 7 p Presented at the 7th Winter Workshop on Nuclear Dynamics, Key West, 27 Jan. - 2 Feb. 1991
(Contract W-7405-eng-36)
(DE91-011392; LA-UR-91-1172; CONF-910135-3) Avail: NTIS HC/MF A02

We discuss the exact numerical solution of the classical relativistic equations of motion for a Lagrangian corresponding to point nucleons interacting with massive scalar and vector meson fields. The equations of motion contain both external retarded Lorentz forces and radiation-reaction forces; the latter involve nonlocal terms that depend upon the past history of the nucleon in addition to terms analogous to those of classical electrodynamics. The resulting microscopic many-body approach to relativistic heavy-ion collisions is manifestly Lorentz covariant and allows for nonequilibrium phenomena, interactions with correlated clusters of nucleons, and particle production. For point nucleons, the asymptotic behavior of nucleonic motion prior to the collision is exponential, with a range in proper time of approximately 0.5 fm. However, this behavior is altered by the finite nucleon size, whose effect we are currently incorporating into our equations of motion. The spacetime nonlocality and retardation that will be present in the solutions of these equations may be responsible for significant collective effects in relativistic heavy-ion collisions. DOE

N91-25825# Nagoya Univ. (Japan). Plasma Science Center.
V(SUB p) X B ACCELERATION OF ELECTRONS BY PHASED GAUSSIAN LASER BEAMS
Ryo Sugihara Sep. 1990 16 p
(DE91-772179; PSC-10) Avail: NTIS HC/MF A03

A system of phased multi-laser beams can construct an effective slow wave which traps and accelerates electrons if an external magnetic field is applied so as to obey the V(sub p) x B acceleration principle. The shape of an individual laser beam is chosen to be Gaussian in one dimension and the wave field is assumed to be linearly polarized. The beam divergence accompanied by the Gaussian beam is also taken into account. A necessary condition for the electron trapping is obtained. Acceleration of the electron satisfying the condition is continuous and subsequently arbitrarily large energy is theoretically possible. DOE

N91-25760*# National Inst. of Standards and Technology, Boulder, CO. Time and Frequency Div.
TRAPPED-ION FREQUENCY STANDARDS
David J. Wineland, W. M. Itano, J. C. Bergquist, J. J. Bollinger, D. J. Heinzen, C. H. Manney, F. L. Moore, M. G. Raizen, and C. S. Weimer *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 53-60 Sponsored by AFOSR and ONR (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20H

N91-25927*# Clark-Atlanta Univ., GA. Dept. of Mathematical and Computer Sciences.
CHOICE OF GAUGE IN 2-PHOTON 1s-2s TRANSITION IN ATOMIC HYDROGEN AND PSEUDOSTATE EXPANSIONS
Abdulalim A. Shabazz *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 25 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 20H

73 NUCLEAR AND HIGH-ENERGY PHYSICS

Includes elementary and nuclear particles; and reactor theory.

For space radiation see *93 Space Radiation.*

N91-25826# Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H., Vienna. Engineering Energie- und Anlagentechnik.
CALCULATION OF THE SOURCE TERM FOR A S1B-SEQUENCE AT A VVER-1000 TYPE REACTOR, PART 1
Gert Sdouz Oct. 1990 61 p Sponsored by Austrian BKA
(OEFZS-4555-Pt-1; ETN-91-99492) Copyright Avail: NTIS HC/MF A04

The behavior of the source term in a VVER-1000 type reactor is calculated using the Source Term Code Package (STCP). The input data are based on the Russian plant Zaporozhye-5. The selected accident sequence is a small break LOCA (Loss Of Coolant Accident) in the hot leg followed by loss of offsite and onsite electric power (S1B sequence). According to the course of the calculation the results are presented and analyzed for each program. Except for the noble gases all release fractions are lower than 0.0001. ESA

N91-25827# Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H., Vienna. Engineering Energie- und Anlagentechnik.
CALCULATION OF THE SOURCE TERM FOR A S1B-SEQUENCE AT A VVER-1000 TYPE REACTOR. PART 2: APPENDIX
Manfred Pachole and Gert Sdouz Oct. 1990 153 p Sponsored by Austrian BKA
(OEFZS-4556-Pt-2; ETN-91-99493) Copyright Avail: NTIS HC/MF A08

The bahavior of the source term in a VVER-1000 type reactor is calculated using the source term code package (STCP). The input data are based on the Russian plant Zaporozhye-5. The selected accident sequence is a small break loss of coolant accident (LOCA) in the hot leg followed by loss of offsite and onsite electric power (S sub 1B sequence). According to the course of the calculation the results are presented and analyzed for each program. Except for the noble gases, all release fractions are lower than 0.0001. ESA

N91-25828# Oak Ridge National Lab., TN.
TOWARD A UNIFIED DYNAMIC MODEL FOR HEAVY ION REACTIONS: EXCLUSIVE MEASUREMENTS OF Br + Al AND Ni + Mg AT INCIDENT ENERGIES NEAR 10 MeV/AMU
D. Shapira, J. G. delCampo, H. Kim, E. L. Chavez (Oak Ridge National Lab., TN.), and J. P. Wielecko 1991 2 p Presented at the 7th Adriatic International Conference on Nuclear Physics, Brioni, Yugoslavia, 27 May - 1 Jun. 1991
(Contract DE-AC05-84OR-21400)
(DE91-011374; CONF-9105144-1) Avail: NTIS HC/MF A01

Energy spectra of light particles (p, d, t, and (alpha)) emitted from collisions of 960 MeV Br-79 with Al-27 and 630 MeV Ni-58 with Mg-24 have been measured in coincidence with evaporation residues from the system formed following full momentum transfer (stopping) of target and projectile. These measurements were performed with a large multidetector system where special attention was paid to energy calibration of the light particle spectra. The measurements show several unexpected features which are discussed in this paper. DOE

N91-25829# Los Alamos National Lab., NM.
A REAL-TIME LONGITUDINAL PHASE-SPACE MEASUREMENT TECHNIQUE FOR H(-) BEAMS
R. C. Connolly and D. P. Sandoval 1991 4 p Presented at the 1991 Institute of Electrical and Electronics Engineers (IEEE) Particle Accelerator Conference (PAC), San Francisco, 6-9 May 1991
(Contract W-7405-eng-36)
(DE91-011412; LA-UR-91-1413; CONF-910505-13) Avail: NTIS HC/MF A01

The longitudinal phase-space distribution of a bunched beam can be determined by selecting short-phase slices of the beam and measuring the energy distribution of each slice. This paper describes a system that should be capable of producing phase-space measurements of an H(-) beam at a rate of 2 Hz. The phase is selected by photoneutralization with a mode-locked laser. A deflector magnet downstream of the neutralization point deflects the charged beam, and the neutral particles enter a spectrometer through a slit covered with a stripping foil. During the 20- to 40-(mu)s laser burst, a ramp signal shifts the laser phase with respect to the beam phase. The same ramp signal controls electric deflection plates in the exit beamline of the spectrometer, which bend the beam perpendicular to the dispersion plane. If the spectrometer magnet bends the beam horizontally, then the beam-current distribution at the focal plane is analyzed horizontally in energy horizontally and vertically in phase. DOE

N91-25830# Lawrence Livermore National Lab., CA.
HIGH AVERAGE POWER SWITCHING FOR LINEAR ACCELERATORS
M. S. DiCapua 1990 71 p Presented at the Workshop on High Average Power Switching (WHAPS), Livermore, 10-11 Oct. 1990
(Contract W-7405-eng-48)
(DE91-011525; UCRL-JC-106836; CONF-9010352-1) Avail: NTIS HC/MF A04

This report summarizes the presentations and the findings of the Workshop on High Average Power Switching (WHAPS) that took place in Livermore, California, on October 10 to 11, 1990. The WHAPS discussed switching technologies that could meet requirements that arise in applications of linear induction accelerators also known as induction linacs. Induction linacs require a switch that will hold-off 250 kV, conduct 30 kA for 150 to 200 ns, operate at 1 to 2 kHz for several second bursts, have better than 1 ns jitter, and last in excess of 10(exp 8) pulses. The workshop reviewed the state-of-the-art of Super-Emissive Cathode Switches, Magnetically Delayed Vacuum Switches and Solid State Switches and considered research and development steps that

would allow these technologies to meet these requirements. DOE

N91-25831# Sandia National Labs., Albuquerque, NM.
HEAT TRANSFER AND THERMAL STRESS ANALYSES OF THE MULTILAYERED SPHERICAL FUEL PARTICLES OF A PARTICLE BED SPACE NUCLEAR REACTOR
D. Dobranich Mar. 1991 272 p
(Contract DE-AC04-76DP-00789)
(DE91-010699; SAND-90-1032) Avail: NTIS HC/MF A12

The heat transfer and thermal stress performance of a multilayered, spherical, fuel particle operating in a particle bed, space nuclear reactor was investigated. The particle bed reactor is a concept that offers the benefit of high power-density operation and results in a low-mass reactor - an advantage for space-based applications. However, such a reactor exposes the spherical fuel particles to a harsh thermal and structural environment unique to this reactor design. Some of the issues of concern that are addressed in this document include: (1) radial, contact-point, and circumferential temperature gradients; (2) temperature gradient thermal stresses; (3) interference thermal stresses; (4) time-independent plasticity; (5) time-dependent, high-temperature creep; (6) thermal history effects with respect to permanent strain formation; (7) temperature-dependent thermal and mechanical material properties; and (8) particle-to-particle contact stresses. These issues were investigated, both analytically and numerically, for a relatively low-temperature (approximately 600 K) particle at the inlet of the particle bed, and for a relatively high-temperature (approximately 2500 K) particle at the outlet of the particle bed. The one-, two-, and three-dimensional results indicate the potential problems and strengths inherent in a multilayered fuel particle of a particle bed reactor. DOE

N91-25832# Brookhaven National Lab., Upton, NY.
THE LIQUID ANNULAR REACTOR SYSTEM (LARS) PROPULSION
J. Powell, H. Ludewig, F. Horn, and R. Lenard (Strategic Defense Initiative Organization, Washington, DC.) 1990 10 p Presented at the Vision-21 Space Travel for the Next Millenium, Cleveland, 3-4 Apr. 1990
(Contract DE-AC02-76CH-00016)
(DE91-010972; BNL-44446; CONF-9004178-3) Avail: NTIS HC/MF A02

A new concept for very high specific impulse (greater than 2,000 seconds) direct nuclear propulsion is described. The concept, termed LARS (Liquid Annular Reactor System) uses liquid nuclear fuel elements to heat hydrogen propellant to very high temperatures (approximately 6,000 K). Operating pressure is moderate (approximately 10 atm), with the result that the outlet hydrogen is virtually 100 percent dissociated to monatomic H. The molten fuel is contained in a solid container of its own material, which is rotated to stabilize the liquid layer by centripetal force. LARS reactor designs are described, together with neutronic and thermal-hydraulic analyses. Power levels are on the order of 200 megawatts. Typically, LARS designs use 7 rotating fuel elements, are beryllium moderated and have critical radii of approximately 100 cm (core L/D is approximately 1.5). DOE

N91-25833# General Electric Co., Philadelphia, PA. Astro Space Div.
DESIGN, FABRICATE, AND PROVIDE ENGINEERING SUPPORT FOR RADIOSOTOPE THERMOELECTRIC GENERATORS FOR NASA'S CRHF AND CASSINI MISSIONS
1991 7 p
(Contract DE-AC03-91SF-18852)
(DE91-011024; DOE/SF-18852/T1) Avail: NTIS HC/MF A02

The technical progress achieved during the period 11 January through 31 March 1991 on Contract DE-AC03-91SF18852.000 Radioisotope Thermoelectric Generators and ancillary activities is described. The system contract consists of the following tasks: (1) Spacecraft Integration and Liaison; (2) Engineering Support; (3) Safety; (4) Qualify Unicouple Fabrication; (5) ETG Fabrication, Assembly and Test; (6) GSE; (7) RTG Shipping and Launch Support; (8) Designs, Reviews, and Mission Applications; (9) Project Management, Quality Assurance and Reliability; and (10) CAGO Acquisition (Capital Funds). The progress achieved is broken down into these tasks. DOE

74 OPTICS

Includes light phenomena; and optical devices.
For lasers see *36 Lasers and Masers.*

N91-25834# Rochester Univ., NY. Dept. of Physics and Astronomy.
THE 6TH ROCHESTER CONFERENCE ON COHERENCE AND QUANTUM OPTICS Final Summary Report, 1 Nov. 1988 - 31 Oct. 1990
J. H. Eberly, L. Mandel, and E. Wolf Nov. 1990 23 p Conference held in Rochester, NY, 26-28 Jun. 1989 LIMITED REPRODUCIBILITY: Availability: Document partially illegible
(Grant AF-AFOSR-0154-89)
(AD-A233350; AFOSR-91-0193TR) Avail: NTIS HC/MF A03 CSCL 20/6

A brief summary is presented of the conference proceedings. Some topics of discussion were: Quantum interference; Squeezing and noise reduction; Atom trapping and cooling; Instabilities and chaos; Atom field interactions; and Fundamental tests of quantum mechanics. E.R.

N91-25835# TRW Space Technology Labs., Redondo Beach, CA.
NONLINEAR OPTICS TECHNOLOGY. VOLUME 2: PHASE CONJUGATED OPTICAL COMMUNICATION LINK, PHASE 3 Final Report, Mar. 1988 - Nov. 1990
J. Brock, M. Caponi, A. Horwitz, L. Lembo, and D. Novoseller 12 Jan. 1991 246 p
(Contract N00014-88-C-0228)
(AD-A233534) Avail: NTIS HC/MF A11 CSCL 20/6

A laser communication link that uses phase conjugation (PC) to correct for atmospheric aberrations due to turbulence was investigated. Significant improvements over conventional optical communication links were demonstrated through experiments and analysis. A 1.1 km four wave mixing (FWM) PC optical communication link propagating through the atmosphere was demonstrated and characterized over a range of atmospheric turbulence conditions and compared to the performance of a conventional link. Four wave mixing was performed in sodium vapor near the sodium D2 resonance line (lambda = 589 nm). Signals with amplitude modulation of 10 kHz to 1 MHz were successfully transmitted and received over this link. Measurements of intensity variance demonstrated that the beam returned by the phase conjugator is corrected for atmospheric turbulence, displaying significantly less intensity variance than a beam returned by a conventional mirror. A 30 m FWM PC communication link was tested with a uniform turbulence generator (turbox) in the laboratory and compared to theoretical performance predictions. GRA

N91-25836 Washington Univ., Seattle.
EXPERIMENTAL INVESTIGATION OF FREE SHEAR-LAYER OPTICS Ph.D. Thesis
Larry Phye Keng Chew 1990 127 p
Avail: Univ. Microfilms Order No. DA9108448

The effects of coherent structures and shear layer fluid mechanics on the optical quality of a propagating laser beam are detailed. A 2.4 m/s shear layer was generated using two parallel streams of gases (a helium/argon mixture and air). The effects of external perturbation on shear flows were also studied to obtain a method of controlling beam propagation. The optical quality of the beam was quantified by the Strehl ratio (ratio of the peak intensity of a beam with phase aberrations to that of an ideal diffraction limited beam). High speed pictures of the intensity profile revealed multiple peaks showing that coherent structures affect beam quality. Measurements of Strehl ratio versus downstream position show that fluid mechanical transition causes the Strehl

ratio to be reduced substantially. In the post-transition region, the Strehl ratio levels off to a constant value and its magnitude is a function of velocity ratio. Optical transmission through shear layers is shown to be governed by the combination of both small three dimensional vortices and large coherent structures that exist within the shear flow. The phase distortion caused by coherent structures is similar to that caused by a sinusoidal phase function. A model is proposed in which the large coherent structures may be modeled as a sinusoidal phase plate. In addition, the leveling off of the Strehl ratio is attributed to the uniformity mixed fluid in the post-transition region. Finally, external perturbation is shown to change the evolution of these coherent structures in such a manner as to improve the Strehl ratio, thereby, providing a means of controlling beam propagation through shear layers.

Dissert. Abstr.

N91-25837# Lawrence Livermore National Lab., CA.
THE POWER CODES FOR ESTIMATING REFLECTED LIGHT INTO AN OFF-AXIS OPTICAL FIBER
D. R. Goosman 2 Mar. 1991 23 p
(Contract W-7405-eng-48)
(DE91-011764; UCRL-LR-103225) Avail: NTIS HC/MF A03

We give a calculation for estimating the amount of laser light collected by an off-axis optical fiber for velocimetry applications. It is assumed that laser light emanating from a single optical fiber is transported to a Lambertian reflector by a two-element lens composed of three spherical surfaces; an off-axis optical fiber adjacent to the laser fiber collects the light used for velocimetry. Four Symphony spreadsheets -- POWER, POWERE, POWERX, and POWERX8 -- are available to trace rays from the laser fiber through the compound lens onto the Lambertian surface to calculate the blur due to spherical aberration and to being out of focus. POWER uses the most approximations and is the fastest, while POWERX8 is the most accurate and slowest. POWER assumes that the light distribution on the Lambertian reflector due to a point source within the laser fiber is flat out to either a maximum radius or an effective radius determined by the ray-tracing routine. This flat distribution is then convolved in two dimensions with the round shape of the laser fiber to provide an analytic formula for light incident on the reflecting surface vs radius. Tracing rays in reverse through the lens provides the size of the illumination at the fiber plane containing all of the light due to a point source at the reflector, as well as a smaller effective size. The radial distribution within this circle is assumed to be flat. POWERE calculates the actual radial distribution of light on the reflector due to a point source at the laser fiber in ten radial bins. However, the distribution at the fiber plane due to a point source at the reflector is still assumed to be flat, as in the POWER code. POWERX relaxes the assumption for POWERE by using ten radial bins at the fiber plane. POWERX8 is the same as POWERX, except that there are 20, rather than 10, bins at both the reflector and the fiber plane, and a fiber-plane illumination distribution is also calculated. DOE

N91-25838# Oak Ridge National Lab., TN.
COUPLING TO LARGE-CORE FIBERS
S. W. Kercel 1991 9 p Presented at the 1991 European Muon Collaboration (EMC) Expo, Orlando, 25-27 Jun. 1991
(Contracts DE-AC05-84OR-21400; DE-FC07-88ID-12691)
(DE91-010811; CONF-9106168-2) Avail: NTIS HC/MF A02

Some instrumentation problems dictate the use of large-core optical fibers, but such applications require efficient coupling. Three areas are of special interest: coupling a collimated beam into a fiber; fiber-to-fiber connection; and coupling from a fiber to an optical instrument. Several problems inherently limit the efficiency of coupling between optical elements. One of the least appreciated is etendue mismatch. In this tutorial, several techniques for predicting and minimizing fiber-coupling losses are considered. To illustrate these points, experimental results are presented for coupling near-infrared (1.064 microns) light fibers with a 400 microns-diameter core. DOE

N91-25839# Lawrence Livermore National Lab., CA.
CHARACTERIZATION OF Mo/B4C MULTILAYERS
A. F. Jankowski and P. L. Perry Mar. 1991 15 p Presented at the Symposium on Tribological Coatings Surface Modification in Conjunction with the International Conference on Metallurgical Coating and Thin Films, San Diego, 22-26 Apr. 1991
(Contract W-7405-eng-48)
(DE91-011192; UCRL-JC-105703; CONF-910485-2) Avail: NTIS HC/MF A03

The Mo/B4C multilayer system is selected for maximum, normal incidence reflection of 6.7nm x-rays. Application in projection lithography requires structural optimization for smooth layering and minimal interface roughness. A transmission electron microscopy analysis of samples prepared in cross-section reveals an intrinsic layer roughness despite attempts to refine sputter deposition parameters. The limitations in growth morphology are attributable to interfacial reactivity from inherent phase instability. DOE

N91-25840* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
OPTICAL JOINT CORRELATOR FOR REAL-TIME IMAGE TRACKING AND RETINAL SURGERY Patent
Richard D. Juday, inventor (to NASA) 2 Jul. 1991 10 p Filed 13 Jul. 1990 Supersedes N91-13997 (29 - 5, p 716)
(NASA-Case-MSC-21509-1; US-Patent-5,029,220;
US-Patent-Appl-SN-560924; US-Patent-Class-382-6;
US-Patent-Class-382-31; US-Patent-Class-382-32;
US-Patent-Class-382-43; US-Patent-Class-382-49;
US-Patent-Class-350-162.13; US-Patent-Class-350-3.68) Avail: US Patent and Trademark Office CSCL 20F

A method for tracking an object in a sequence of images is described. Such sequence of images may, for example, be a sequence of television frames. The object in the current frame is correlated with the object in the previous frame to obtain the relative location of the object in the two frames. An optical joint transform correlator apparatus is provided to carry out the process. Such joint transform correlator apparatus forms the basis for laser eye surgical apparatus where an image of the fundus of an eyeball is stabilized and forms the basis for the correlator apparatus to track the position of the eyeball caused by involuntary movement. With knowledge of the eyeball position, a surgical laser can be precisely pointed toward a position on the retina.

Official Gazette of the U.S. Patent and Trademark Office

N91-25841* National Aeronautics and Space Administration. Pasadena Office, CA.
HIGH-GAIN AlGaAs/GaAs DOUBLE HETEROJUNCTION DARLINGTON PHOTOTRANSISTORS FOR OPTICAL NEURAL NETWORKS Patent
Jae H. Kim, inventor (to NASA) and Steven H. Lin, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 25 Jun. 1991 12 p Filed 11 Oct. 1990 Supersedes N91-13995 (29 - 5, p 716)
(Contract NAS7-918)
(NASA-Case-NPO-18101-1-CU; US-Patent-5,027,182;
US-Patent-Appl-SN-596133; US-Patent-Class-357-46;
US-Patent-Class-357-16; US-Patent-Class-357-17;
US-Patent-Class-357-34; US-Patent-Class-357-30;
Int-Patent-Class-H01L-27/02; Int-Patent-Class-H01L-29/161)
Avail: US Patent and Trademark Office CSCL 20F

High-gain MOCVD-grown (metal-organic chemical vapor deposition) AlGaAs/GaAs/AlGaAs n-p-n double heterojunction bipolar transistors (DHBTs) and Darlington phototransistor pairs are provided for use in optical neural networks and other optoelectronic integrated circuit applications. The reduced base doping level used results in effective blockage of Zn out-diffusion, enabling a current gain of 500, higher than most previously reported values for Zn-diffused-base DHBTs. Darlington phototransitor pairs of this material can achieve a current gain of over 6000, which satisfies the gain requirement for optical neural network designs, which advantageously may employ neurons comprising the Darlington phototransistor pairs in series with a light source.

Official Gazette of the U.S. Patent and Trademark Office

75 PLASMA PHYSICS

Includes magnetohydrodynamics and plasma fusion.

For ionospheric plasmas see *46 Geophysics*. For space plasmas see *90 Astrophysics*.

N91-25842# Aerospatiale Aquitaine, Saint-Medard en Jalles (France). Div. Systemes Strategiques et Spatiaux.
WASTE DESTRUCTION BY PLASMA
Didier Cretenot, Jacques vanRenterghem (Soretel, Cergy, France), Maxime Labrot, and Didier Pineau 1991 8 p Presented at EPRI/CMP Plasma Symposium, Palo Alto, CA, Mar. 1990
(Rept-911-430-123; ETN-91-99295) Avail: NTIS HC/MF A02

The use of arc plasma for waste destruction is addressed. Types of treatable waste, processes for liquid and solid or pasty wastes, and the present state of these techniques in France are described. The efficiency of arc plasma technology in the destruction of liquid organochlorinated waste compounds in commercial size units, particularly mobile units, is demonstrated. Many trials with solid waste demonstrate that plasmas are a highly efficient solution. ESA

N91-25843*# Colorado State Univ., Fort Collins. Dept. of Mechanical Engineering.
AN EXPERIMENTAL INVESTIGATION OF HOLLOW CATHODE-BASED PLASMA CONTACTORS Ph.D. Thesis
John D. Williams May 1991 121 p
(Grant NAG3-776)
(NASA-CR-187120; NAS 1.26:187120) Avail: NTIS HC/MF A06 CSCL 20I

Experimental results are presented which describe operation of the plasma environment associated with a hollow cathod-based plasma contactor collecting electrons from or emitting them to an ambient, low density Maxwellian plasma. A one-dimensional, phenomenological model of the near-field electron collection process, which was formulated from experimental observations, is presented. It considers three regions, namely, a plasma cloud adjacent to the contactor, an ambient plasma from which electrons are collected, and a double layer region that develops between the contactor plasma cloud and the ambient plasma regions. Results of the electron emission experiments are also presented. An important observation is made using a retarding potential analyzer (RPA) which shows that high energy ions generally stream from a contactor along with the electrons being emitted. A mechanism for this phenomenon is presented and it involves a high rate of ionization induced between electrons and atoms flowing together from the hollow cathode orifice. This can result in the development of a region of high positive potential. Langmuir and RPA probe data suggest that both electrons and ions expand spherically from this hill region. In addition to experimental observations, a one-dimensional model which describes the electron emission process and predicts the phenomena just mentioned is presented and shown to agree qualitatively with these observations. Author

N91-25844 Rensselaer Polytechnic Inst., Troy, NY.
ANALYSIS AND DESIGN OF AN ULTRA-HIGH-TEMPERATURE, HYDROGEN-FUELED MHD GENERATOR AS AN OPEN CYCLE POWER SUPPLY Ph.D. Thesis
Jeffrey P. Moder 1990 251 p
Avail: Univ. Microfilms Order No. DA9111066

The theoretical analysis of a partially-ionized hydrogen gas flow (gas temperatures of approximately 10,000 to 20,000 K) through a particular class of magnetohydrodynamic (MHD) generators and the preliminary design of these MHD generators as open cycle, electric power supplies are performed. Analysis of the gas flow through these ultra-high temperature MHD generators requires a coupled gas dynamics/radiative heat transfer solution. Gas dynamics are modeled by a set of quasi-one-dimensional, nonlinear differential equations which account for friction, convective and radiative heat transfer and the interaction between the ionized gas and applied magnetic field. Radiative heat transfer is modeled using non-gray, absorbing-emitting two- and three-dimensional P-1 approximations which permit an arbitrary variation of the spectral absorption coefficient with frequency. Gas dynamics and radiative heat transfer are coupled through the energy equation, and through the temperature-and density-dependent absorption coefficient. The resulting nonlinear, elliptic problem is solved by iterative methods in which relaxed values for radiative losses and temperature and density distributions are exchanged between computational models for the gas dynamics and radiative heat transfer. The design of efficient MHD generators is formulated as an optimization problem. The objective is to maximize the extraction ratio subject to several constraints, including limits on heat transfer to the generator walls, distorting of the applied magnetic field and maximum Hall parameters. A numerical optimization code is used to find local optima within the feasible design space, given some approximation of the actual radiative loss distribution within the generator. Actual coupled solutions for some of these designs are then generated.
Dissert. Abstr.

N91-25845# National Inst. for Fusion Science, Nagoya (Japan).
MULTI-DIMENSIONAL CUBIC INTERPOLATION FOR ICF HYDRODYNAMICS SIMULATION
Takayuki Aoki and Takashi Yabe (Gunma Univ., Maebashi, Japan) Apr. 1991 19 p
(NIFS-82; ISSN-0915-633X) Avail: NTIS HC/MF A03

A new interpolation method is proposed to solve the multi-dimensional hyperbolic equations which appear in describing the hydrodynamics of inertial confinement fusion (ICF) implosion. The advection phase of the cubic-interpolated pseudo-particle (CIP) is greatly improved by assuming the continuities of the second and the third spatial derivatives in addition to the physical value and the first derivative. These derivatives are derived from the given physical equation. In order to evaluate the new method, Zalesak's example is tested, and the authors obtain good results.
Author

N91-25846# National Inst. for Fusion Science, Nagoya (Japan).
DECAY PROCESS OF A MAGNETIC ISLAND BY FORCED RECONNECTION
K. Nagasaki (Kyoto Univ., Japan) and K. Itoh Mar. 1991 38 p Submitted for publication
(NIFS-80; ISSN-0915-633X) Avail: NTIS HC/MF A03

Time evolution of a magnetic island by forced reconnection, especially the decay process is analyzed. A simple slab model is used and the magnetic island is considered to have a single helicity. The plasma is assumed to be incompressible. The evolution time is affected by the presence of an original magnetic island, and the current layer width depends on the magnetic island width, when the island is relatively wide compared to the current layer. In the presence of a magnetic island, even if the magnetic Reynolds number increases, the current layer does not become narrower. This leads to the slow evolution of the magnetic island. It is found that the time scale is required to reach the last equilibrium regardless of the nonlinear terms. This is slower than that of the growth process. Author

N91-25847# National Inst. for Fusion Science, Nagoya (Japan).
MODEL OF DIVERTOR BIASING AND CONTROL OF SCRAPE-OFF LAYER AND DIVERTOR PLASMAS
K. Nagasaki (Kyoto Univ., Japan), K. Itoh, and S.-I. Itoh Feb. 1991 36 p Sponsored in part by Ministry of Education, Science and Culture
(NIFS-79; ISSN-0915-633X) Avail: NTIS HC/MF A03

Analytic model of the divertor biasing is described. For the given plasma and energy sources from the core plasma, the heat and particle flux densities on the divertor plate as well as scrape-off-layer (SOL)/divertor plasmas are analyzed in a slab model. Using a two-dimensional model, the effects of the divertor biasing and SOL current are studied. The conditions to balance the plasma temperature or sheath potential on different divertor plates are obtained. Effect of the SOL current on the heat channel width is also discussed. Author

N91-25848# National Inst. for Fusion Science, Nagoya (Japan).
SUPPRESSION OF MAGNETIC SURFACE BREAKING BY SIMPLE EXTRA COILS IN A FINITE BETA EQUILIBRIUM OF HELICAL SYSTEM
T. Hayashi, A. Takei, Nobuyoshi Ohyabu, and Tetsuya Sato Feb. 1991 14 p
(NIFS-76; ISSN-0915-633X) Avail: NTIS HC/MF A03

A simple method is proposed to suppress actively the breaking of magnetic surfaces which occurs in l = 2 Heliotron/Torsatron equilibria, by which fairly high beta equilibria with clearly nested magnetic surfaces can be realized without changing other physical properties such as rotational transform profile and the well depth. Author

N91-25849# National Inst. for Fusion Science, Nagoya (Japan).
HIGH TEMPERATURE DIVERTOR PLASMA OPERATION
Nobuyoshi Ohyabu Feb. 1991 20 p
(NIFS-77; ISSN-0915-633X) Avail: NTIS HC/MF A03

High temperature divertor plasma operation was proposed, which is expected to enhance the core energy confinement and eliminates the heat removal problem. The heat flux is guided through divertor channel to a remote area with a large target surface, resulting in low heat load on the target plate. This allows pumping of the particles escaping from the core and hence maintaining of the high divertor temperature, which is comparable to the core temperature. The energy confinement is then determined by the diffusion coefficient of the core plasma, which was observed to be much lower that the thermal diffusivity. Author

N91-25850# National Inst. for Fusion Science, Nagoya (Japan).
SIMULATION STUDY OF TOROIDAL PHASE-LOCKING MECHANISM IN REVERSED-FIELD PINCH PLASMA
Kanya Kusano, Teruo Tamano (General Atomic Co., San Diego, CA.), and Tetsuya Sato Feb. 1991 28 p
(NIFS-78; ISSN-0915-633X) Avail: NTIS HC/MF A03

The toroidal phase locking process of kink modes in the reversed-field pinch (RFP) plasma is investigated in detail by means of the magnetohydrodynamic (MHD) simulation. The physical mechanism of phase locking is clarified. The most dominant two linearly unstable kink modes rule over the evolution of other kink modes whereby phase locking takes place. It is confirmed that the phase locking process is not a special phenomenon subject to the resistive boundary condition, but a common feature of the MHD relaxation process in the RFP. The relation between the phase locking and MHD relaxation processes is briefly discussed. Author

N91-25851# Institute of Plasma Physics, Prague (Czechoslovakia). Academy of Sciences
MULTIJUNCTION GRILL RESPONSE TO PONDEROMOTIVE EFFECTS AS PLASMA PERIPHERY
O. Hurtak, R. Klima, and V. A. Petrzilka Oct. 1990 16 p
(IPPCZ-303) Avail: NTIS HC/MF A03

A nonlinear coupling code that accounts for ponderomotive force effects at the plasma periphery is developed for a multijunction grill. By increasing the radio frequency power density, the power reflection coefficient remains rather low for the frequency of 4.6 GHz at the expense of the deterioration of the power distribution among subsidiary waveguides. The consequent danger of overloading individual waveguides is expected to be still greater for lower frequencies. Author

N91-25852# Institute of Plasma Physics, Prague (Czechoslovakia). Academy of Sciences.
SIMULATION OF ELECTRON AND ION BIPOLAR FLOW IN HIGH CURRENT DIODE WITH MAGNETIC INSULATION
P. Vrba and V. I. Engelko (Nauchno-Issledovatelskii Inst. Ehlekt-Rofizicheskoj Apparatury, Leningrad, USSR) Aug. 1990 31 p
(IPPCZ-301) Avail: NTIS HC/MF A03

Numerical simulation of formation of the collector ion flow in magnetically insulated ion diode (MID) with hollow cylindrical and cone-shaped cathode was studied. Such cathodes are often used for obtaining tubular high current electron microsecond beams. The ions, emitted by the collector and forming as a result of the ionization of the residual gas by electron beam, are focused into the cathode plasma region. This effect can negatively influence the diode operation. Author

N91-25853# Institute of Plasma Physics, Prague (Czechoslovakia). Academy of Sciences.
D.C. - ARC PLASMA GENERATOR FOR NONEQUILIBRIUM PLASMACHEMICAL PROCESSES
J. Kvaltin Jun. 1990 17 p
(IPPCZ-302) Avail: NTIS HC/MF A03

The analysis of conditions for generation of nonequilibrium plasma to plasmachemical processes is made and the design of d.c.-arc plasma generator on the base of integral criterion is suggested. The measurement of potentials on the plasma column of that generator is presented. Author

N91-25854# Institute of Plasma Physics, Prague (Czechoslovakia). Academy of Sciences.
SUPPRESSION OF MAGNETIC FLUCTUATIONS BY LOWER HYBRID CURRENT DRIVE ON THE CASTOR TOKAMAK
M. Valovic May 1990 12 p
(IPPCZ-300) Avail: NTIS HC/MF A03

Preliminary observations of the effect of lower hybrid current drive on magnetic turbulence in the CASTOR tokamak are summarized. If waves drive 50 pct. of the total plasma current, the level of broadband magnetic turbulence is suppressed by a factor of 2 to 3. Author

N91-25855# Institute of Plasma Physics, Prague (Czechoslovakia). Academy of Sciences.
HARD X RAY STUDIES ON THE CASTOR TOKAMAK
Jan Mlynar Apr. 1990 45 p
(IPPCZ-299) Avail: NTIS HC/MF A03

This report forms the basis for quantitative measurements of hard x ray radiation. It deals with chosen general facts that must be taken into account before starting the experiments. Apart from this, first qualitative results of hard x ray measurements on the Castor tokamak are presented. A series of integral measurements were performed which mapped the azimuthal dependence of the radiation. Author

N91-25856# Oak Ridge National Lab., TN.
CONFIGURATION CONTROL, FLUCTUATIONS, AND TRANSPORT IN LOW-COLLISIONALITY PLASMAS IN THE ATF TORSATRON
J. H. Harris, M. Murakami, L. R. Baylor, J. D. Bell, T. S. Bigelow, B. A. Carreras, R. J. Colchin, E. C. Crume, Jr., N. Dominguez, and R. A. Dory et al 1991 6 p Presented at the 18th European Conference on Controlled Fusion and Plasma Physics, Berlin, Fed. Republic of Germany), 3-7 Jun. 1991
(Contract DE-AC05-84OR-21400)
(DE91-010807; CONF-910609-6) Avail: NTIS HC/MF A02

In low-collisionality plasmas confined in tokamaks and stellarators, instabilities driven by particles trapped in inhomogeneities of the magnetic fields could be important in increasing plasma transport coefficients. In the Advanced Toroidal Facility (ATF), an (ell) = 2, M = 12 field-period stellarator device with major radius R = 2.1 m, average plasma minor radius a = 0.27 m, central and edge rotational transforms chi sub 0 approx. 0.3, chi sub a approx. 1, the effects of electron trapping in the helical stellarator field are expected to be important in plasmas with (bar n) sub e approx. 5 x 10(sup 12) cm(sup -3), T(sub e0) approx. 1 keV. Such plasmas have already been sustained for long pulses (20 s) using 150 to 400 kW of 53.2 GHz ECH power at B = 0.95 T. Transport analysis shows that for rho = r/a less than or = 1/3, the electron anomalous transport is less than or = 10 x the neoclassical value, while at rho = 2/3 it is 10 to 100 x neoclassical; this is compatible with expectations for transport enhancement due to dissipative trapped-electron modes. DOE

N91-25857# Science Applications International Corp., McLean, VA.
ALPHA PARTICLE EFFECTS ON MHD BALLOONING
11 Apr. 1991 36 p
(Contract DE-AC05-89ER-53284)
(DE91-011025; DOE/ER-53284/T1) Avail: NTIS HC/MF A03

During the period, as the first step towards the goal of detail understanding of the effects of alpha particle on MHD Ballooning Modes, a new numerical approach to investigate the stability of low frequency fluctuations in high temperature tokamaks was developed by solving the gyrokinetic equations for the ion and electron directly as an initial value problem. The advantage of this approach is the inclusion of many important kinetic features of the problem without approximations and computationally more economical than particle-pushing simulation. The ion temperature gradient mode was investigated to benchmark this new simulation technique. Previous results in literature were recovered. Both the adiabatic electron model and the full drift kinetic electron model are studied. Numerical result shows that the full drift kinetic electron model is more unstable. The development of subcycling technique to handle the fast electron bounce time is particularly significant to apply this new approach to the alpha particle problem since alpha particle bounce frequency is also significantly higher than the mode frequency. DOE

N91-25858# General Atomic Co., San Diego, CA.
US/JAPAN WORKSHOP ON TOKAMAK FUSION POWER REACTOR STUDIES
K. R. Schultz Mar. 1991 38 p Workshop held in Los Angeles, CA, 15-17 Oct. 1990
(Contract DE-AC03-89ER-52153)
(DE91-011115; GA-A-20418; CONF-9010345-Summ) Avail: NTIS HC/MF A03

The second U.S./Japan Workshop on Tokamak Fusion Power Reactor Studies was organized by Mr. Sam Berk of the U.S. Department of Energy, Office of Fusion Energy, and Dr. Yasushi Seki of the Japan Atomic Energy Research Institute, Fusion Reactor System Laboratory. This meeting report reviews the technical presentations that were made at the workshop, and summarizes the technical discussions that resulted from those workshop presentations. The objectives of the workshop were to further mutual understanding of tokamak power fusion reactor studies being done in the US and in Japan, to provide technical review of the technical assumptions and analyses being performed as part of these studies, and to maximize the benefit reactor studies programs of the two countries can take of each other. This report is organized to follow chronologically through that agenda. DOE

N91-25859# General Atomic Co., San Diego, CA.
RECENT GASEOUS DIVERTOR EXPERIMENTS IN DIII-D
T. W. Petrie, S. Lippmann, M. A. Mahdavi, D. N. Hill, A. Futch, D. Buchenauer, and C. Klepper (Oak Ridge National Lab., TN.) Apr. 1991 5 p Presented at the 18th European Conference on Controlled Fusion and Plasma Physics, Berlin, Fed. Republic of Germany, 3-7 Jun. 1991
(Contracts DE-AC03-89ER-51114; DE-AC05-84OR-21400; W-7405-eng-48; DE-AC04-76DR-00789)
(DE91-011139; GA-A-20478; CONF-910609-9) Avail: NTIS HC/MF A01

The expected heat loads at the divertor plates for next generation tokamaks raise concern from the standpoints of both mechanical integrity and erosion rate. The peak heat flux anticipated for the present International Thermonuclear Experimental Reactor (ITER) design are predicted to be as high as approximately 20 MW/sq m. High peak heat fluxes can be reduced to more manageable levels by increasing the radiated power in the divertor, which has the additional benefit of reducing divertor plasma temperature and sheath potential, thereby lowering the ion impact energy. Neutral deuterium gas injection into or near the divertor has been suggested as one means of reducing heat flux via radiation and/or momentum transfer and ionization collisions with the neutral gas; this method is often referred to as the gaseous divertor. In this paper we report on experiments in which the gaseous divertor approach was used to reduce the heat flux on the divertor tiles of the DIII-D tokamak during ELMing H-mode discharges. DOE

N91-25860# General Atomic Co., San Diego, CA.
DEPENDENCE OF THE DIII-D BETA LIMIT ON THE CURRENT PROFILE
E. J. Strait, M. S. Chu, J. R. Ferron, L. L. Lao, T. H. Osborne, T. S. Taylor, A. D. Turnbull, and E. A. Lazarus (Oak Ridge National Lab., TN.) Apr. 1991 5 p Presented at the 18th European Conference on Controlled Fusion and Plasma Physics, Berlin, Fed. Republic of Germany, 3-7 Jun. 1991
(Contracts DE-AC03-89ER-51114; DE-AC05-84OR-21400)
(DE91-011140; GA-A-20477; CONF-910609-7) Avail: NTIS HC/MF A01

The maximum beta values achieved in DIII-D are not fully described by the simple scaling law beta(sub max) proportional to I/aB. There is, in addition, a dependence on the form of the current profile as parameterized by the safety factor q and internal inductance l(sub i). The maximum experimentally achieved value of normalized beta beta(sub N) = beta/(I/aB) varies from 3.5 at low safety factor q (q(sub 95) less than 3) to 5 at higher values of q. At low q, discharges are terminated by disruptions at high (beta)(sub N) and at both the low and high l(sub i) boundaries of the stable range. These disruptions are attributed to external and global kink modes. At higher q, such disruptions are much less frequent, and beta is limited by slowly growing resistive modes, fishbones, and possibly by ballooning modes. At each value of q, the maximum beta tends to increase with internal inductance l(sub i). A numerical study of kink mode stability has shown a similar trend for optimized pressure profiles. These observations have suggested a new scaling law for the operational beta limit: beta(sub max) = 4 l(sub i)(I/aB), which fits the DIII-D data well. DOE

N91-25861# Lawrence Livermore National Lab., CA.
ABSORPTION MEASUREMENTS OF RADIATIVELY HEATED LOW-Z MATERIALS
B. A. Hammel, D. R. Kania, J. F. Seely, R. Doyas, R. W. Lee, and C. A. Igelsias Jan. 1990 13 p Presented at the International Workshop on Radiative Properties of Hot Dense Matter, Sarasota, 22-26 Oct. 1990
(Contract W-7405-eng-48)
(DE91-011182; UCRL-JC-105910; CONF-9010298-8) Avail: NTIS HC/MF A03

The opacity of radicatively heated low-Z foils (Z = 5-7) in the spectral region of their k-edges (approximately 200-500 eV), with the eventual goal of investigating radiative transfer in non-LTE plasmas. In these experiments one arm of the NOVA laser (4.2 kJ of 0.53 micron light in a 1 ns pulse) is incident on a Au burn-through foil (0.25 micron thick), producing a soft x ray source that radiatively heats a low-Z sample. The sample is approximatly 1 micron thick and is placed in close proximity to the Au foil. Absorption spectra are obtained by either viewing the soft x rays from the Au foil passing through the sample, or by using the Au foil passing through the sample, or by using a second arm of the NOVA laser to create an independent x-ray backlighter pulse from a separate Au foil at a specific time. High resolution spectral measurements (lambda/lambda delta is greater than 3000) are obtained with a 3 m Rowland circle instrument: data are recorded on Kodak 101-05 photographic plate. Preliminary comparisons with a low-Z opacity code, OPAL, are presented. DOE

N91-25862# Lawrence Livermore National Lab., CA.
PLASMA SPECTROSCOPY SIMULATIONS WITH THE ALTAIR CODE
J. I. Castor, P. G. Dykema, R. I. Klein, and C. A. Back (Ecole Polytechnique, Palaiseau, France) Jan. 1991 8 p Presented at the International Workshop on Radiative Properties of Hot Dense Matter, Sarasota, 22-26 Oct. 1990
(Contract W-7405-eng-48)
(DE91-011201; UCRL-JC-105070; CONF-9010298-9) Avail: NTIS HC/MF A02

The non-LTE radiation transport and atomic kinetics code

ALTAIR is described, with emphasis on the version that treats 1-D slab geometry. The methods used in the code are summarized, and the code's capabilities are listed. As an illustration of the application of ALTAIR to the analysis of laboratory plasma spectroscopy experiments, some of the results from a simulation of a resonance x ray photopumping experiment will be shown. DOE

N91-25863# Wisconsin Univ., Madison. Plasma Physics Research.
SELF-CONSISTENT FIELD ERROR EFFECTS IN REVERSED FIELD PINCH PLASMAS Ph.D. Thesis
K. L. Sidikman Jul. 1990 284 p
(Contract DE-FG02-85ER-53212)
(DE91-011426; DOE/ER-53212/157) Avail: NTIS HC/MF A13

This work concerns magnetic field perturbations induced inside a reversed field pinch (RFP) plasma by field errors at the plasma edge. Such perturbations can have an important effect on the plasma behavior. Some of the key features of the RFP depend upon an edge region of reversed toroidal field. Perturbations with poloidal mode number (m) equal to zero resonate with the plasma at the field reversal point and threaten to disrupt this region. Perturbations with m = 1 can influence the instabilities that play a role in maintaining the RFP state. In assessing these effects, it must be remembered that interaction with the plasma can also alter the perturbations. Thus, the plasma-perturbation interaction should be calculated self-consistently. Such a calculation was undertaken, combining a field error model with a model of the RFP equilibrium and allowing their interaction to be computed via the three-dimensional magnetohydrodynamic equations. Realistic plasma features, such as a partially-relaxed equilibrium, were incorporated. In addition, the use of a set of dynamical equations allowed perturbed flow and finite resistivity and viscosity to come into play. It is shown that all of these have measurable effects. DOE

N91-25864# Wisconsin Univ., Madison. Plasma Physics Research.
MAGNETIC FLUCTUATION MEASUREMENTS IN THE TOKAPOLE 2 TOKAMAK Ph.D. Thesis
M. A. LaPointe Sep. 1990 115 p
(Contract DE-FG02-85ER-53198)
(DE91-011427; DOE/ER-53198/161) Avail: NTIS HC/MF A06

Magnetic fluctuation measurements have been made in the Tokapole II tokamak in the frequency range 10 kHz less than or equal to f less than or equal to 5 MHz. The fluctuations above 500 kHz varied greatly as the effective edge safety factor, q(sub a), was varied over the range 0.8 less than or equal to q(sub a) less than or equal to 3.8. As q(sub a) was varied from 3.8 to 0.8 the high frequency magnetic fluctuation amplitude increased by over three orders of magnitude. The fluctuation amplitude for 0.5 to 2.0 MHz was a factor of 10 lower than the fluctuation amplitude in the range 100 to 400 kHz for q(sub a) of 0.8. When q(sub a) was increased to 3.8 the difference between the differing frequency ranges increased to a factor of 10(exp 3). Comparison of the measured broadband fluctuation amplitudes with those predicted from thermally driven Alfven and magnetosonic waves shows that the amplitudes are at least 1000 times larger than the theoretical predictions. This indicates that there is some other mechanism driving the higher frequency magnetic fluctuations. Estimates show that the contribution by the magnetic fluctuations above 500 kHz to the estimated electron energy loss from stochastic fields is negligible. The profiles of the various components of the magnetic fluctuations indicate the possibility that the shear in the magnetic field may stabilize whatever instabilities drive the magnetic fluctuations. DOE

N91-25865# California Univ., Berkeley. Lawrence Berkeley Lab.
SPECTROSCOPIC MEASUREMENT OF H(1S) AND H2(v(DOUBLE PRIME),J(DOUBLE PRIME)) IN AN H(-) ION SOURCE PLASMA Ph.D. Thesis
G. C. Stutzin Aug. 1990 280 p
(Contract DE-AC03-76SF-00098)
(DE91-011879; LBL-30541) Avail: NTIS HC/MF A13

Low pressure H2 discharges have been used for some time as sources of H(-) ions. These discharges contain many different species of particles which interact with each other and with the walls of the discharge chamber. Models exist that predict the populations of the various species for given macroscopic discharge parameters. However, many of the cross sections and wall catalyzation coefficients are unknown or somewhat uncertain. Therefore, it is of interest to measure the populations of as many of these species as possible, in order to determine the validity of the models. These models predict that H(-) is created predominantly by the two-step process of vibrational excitation of hydrogen molecules followed by dissociative attachment of slow electrons to these vibrationally excited hydrogen molecules. Many different collisional processes must be included in the models to explain the dependence of the various populations upon macroscopic parameters. This work presents results of spectroscopic measurements of the density and translational temperature of hydrogen atoms and of specific rotationally and vibrationally excited states of electronic ground-state H2, in a discharge optimized for H(-) production, as well as conventional measurements of the various charged species within the plasma. The spectroscopic measurements are performed directly by narrowband, single-photon absorption in the vacuum ultraviolet. DOE

N91-25866# Sandia National Labs., Albuquerque, NM.
PROGRESS IN LIGHT ION FUSION
J. P. Quintez, R. G. Adams, G. O. Allshouse, L. D. Bacon, J. E. Bailey, D. D. Bloomquist, G. A. Chandler, R. S. Coats, D. L. Cook, and M. E. Cuneo et al 1991 11 p Presented at the International Atomic Energy Agency (IAEA) Technical Committee Meeting on Drivers for Inertial Confinement Fusion (ICF), Osaka (Japan), 15-19 Apr. 1991
(Contract DE-AC04-76DP-00789)
(DE91-010854; SAND-91-0859C; CONF-9104210-2) Avail: NTIS HC/MF A03

Advances in ion beam theory, diagnostics, and experiments in the past two years have enabled efficient generation of intense proton beams on PBFA (Particle Beam Fusion Accelerator) II and focusing of the beam power to 5.4 TW/sq cm. Improvements in the uniformity of the ion diode magnetic field and anode shaping produced a proton beam with good azimuthal symmetry. The beam was diagnosed using conical targets in concert with inner shell excitation x ray cameras and ion pinhole cameras. The measured asymmetry was less than 15 percent, a level adequate to begin initial studies of the beam/target interaction with proton beams. Substantial improvements in power density beyond the present level require an ion beam that is more magnetically stiff and has lower ion divergence. Thin film based lithium sources have produced more than 150 kJ of lithium energy above 6 MV. For the first 15 ns of the ion beam pulse, multiple diagnostics show a high purity lithium beam. Simulations using the 3-D electromagnetic particle-in-cell code QUICKSILVER have identified an early-time diocotron instability in the electron flow in the diode. Analytic calculations, which include a charge-neutral region in the diode inside the beam acceleration gap, give a growth rate for the diocotron instability that is in good agreement with the simulations. In the QUICKSILVER simulations, the early-time diocotron instability eventually gives way to a low frequency instability with a period on the order of the ion beam transit time time scale. When this occurs, the ion divergence increases substantially as a result of the enhanced coupling. Results from the ion diode simulations and analytic theory are discussed, as well as recent developments in diagnostics for the measurement of ion divergence. DOE

N91-25867# Oak Ridge National Lab., TN.
EFFECT OF THE ASPECT RATIO ON THE STABILITY LIMITS OF TJ-II-LIKE STELLARATORS
A. Varias, A. Alvarez, A. L. Fraguas, C. Alejaldre, N. Dominguez, B. A. Carreras, and V. E. Lynch 1991 4 p Presented at the 1991 European Physical Society Meeting, Berlin, Fed. Republic of

Germany, 3-7 Jun. 1991
(Contract DE-AC05-84OR-21400)
(DE91-011364; CONF-9106178-1) Avail: NTIS HC/MF A01

The four-field-period device TJ-II has a major radius of 1.5 m and an average plasma radius of 0.10 to 0.25 m, with a typical plasma aspect ratio A(sub P) of 10. In the infinite aspect ratio, helically symmetric limit, the region of the stability to low-n modes has been shown to extend to average betas of at least 40 percent, for a relatively highly indented plasma. It is possible to approximate the helically symmetric limit from the actual TJ-II parameters increasing the number of toroidal periods N(sub T) and choosing the major radius R(sub O) such as to obtain a constant helical pitch h = N(sub T)/R(sub O). In this way the aspect ratio per period is fixed. In this work we analyze a shear-less TJ-II configuration with a rotational transform per period of 0.36 and a vacuum magnetic well of 3.5 percent. By taking for N(sub T) the values N(sub T) = 3, 4, 5, 8, 10, 11, 12, 19 and 100 a sequence of equilibria is generated. These equilibria are calculated with the fixed boundary version of the VMEC code. The Mercier stability properties are then analyzed. DOE

N91-25868# Lawrence Livermore National Lab., CA.
EFFECTS OF ELECTRIC MICROFIELDS ON ARGON DIELECTRONIC SATELLITE SPECTRA IN LASER-PRODUCED PLASMAS
L. A. Woltz, V. L. Jacobs (Naval Research Lab., Washington, DC.), C. F. Hooper, Jr., and R. Mancini Jan. 1991 21 p
(Contract W-7405-eng-48)
(DE91-011445; UCRL-CR-105952) Avail: NTIS HC/MF A03

Theoretical spectral-line profiles have been obtained for dielectronic satellite transitions in helium-like and lithium-like argon ions. Particular emphasis has been given to the systematic and self-consistent incorporation of the non-local thermodynamic equilibrium (LTE) autoionizing-level populations, together with the line broadening effects, which are due to autoionization processes, radiative transitions, electron collisions, and the action of the plasma ion-produced electric microfields. An investigation has been carried out of the effects of the plasma electric microfields on predicted dielectronic satellite line-intensity ratios, and a discussion is presented on the consequences of the electric microfield effects for the spectroscopic determination of basic physical properties in laser-produced plasmas. DOE

N91-25869# California Univ., Berkeley. Dept. of Physics.
PLASMA X RAY FOCUSING STUDIES
R. W. Falcone Oct. 1990 13 p
(Contract W-7405-eng-48)
(DE91-011446; UCRL-CR-105983) Avail: NTIS HC/MF A03

Plasmas generated by x ray irradiation achieve densities and temperatures of interest to astrophysics, inertial confinement fusion and atomic physics. We have developed and characterized a facility capable of focusing broadband x rays from a laser produced plasma to flux levels of approximately 10(exp 3) J/sq cm. In addition, we have designed a Schwarzschild microscope suitable for focusing x ray lasers for use in nonlinear optics experiments. DOE

N91-25870# Texas Univ., Austin. Inst. for Fusion Studies.
TOROIDAL PLASMA REACTOR WITH LOW EXTERNAL MAGNETIC FIELD
A. D. Beklemishev, R. R. Khayrutdinov, V. I. Petviashvili, T. Tajima, V. A. Gordin, and T. Tajima Jan. 1991 35 p
(Contract DE-FG05-80ET-53088)
(DE91-011522; DOE/ET-53088/474; IFSR-474) Avail: NTIS HC/MF A03

A toroidal pinch configuration with safety factor q less than 0.5 decreasing from the center to periphery without field reversal is proposed. This is capable of containing high pressure plasma with only small toroidal external magnetic field. Sufficient conditions for magnetohydrodynamic stability are fulfilled in this configuration. The stability is studied by constructing the Lyapunov functional and investigating its extrema both analytically and numerically. Comparison of the Lyapunov stability conditions with the conventional linear theory is carried out. Stable configurations are found with average (beta) near 15 percent, with magnetic field associated mainly with plasma current. The (beta) value calculated with the external magnetic field can be over 100 percent. Fast charged particles produced by fusion reactions are asymmetrically confined by the poloidal magnetic field (and due to the lack of strong toroidal field). They thus generate a current in the noncentral part of plasma to reinforce the poloidal field. This current drive can sustain the monotonic decrease of q with radius. DOE

N91-25871# Lawrence Livermore National Lab., CA.
ANALYSIS OF TIME- AND SPACE-RESOLVED Na-, Ne-, AND F-LIKE EMISSION FROM A LASER-PRODUCED BROMINE PLASMA
W. H. Goldstein, B. K. F. Young, A. L. Osterheld, R. E. Stewart, R. S. Walling, A. Bar-Shalom, and M. Klapisch 16 Jan. 1991 8 p Presented at the International Workshop on Radiative Properties of Hot Dense Matter, Sarasota, 22-26 Oct. 1990
(Contract W-7405-eng-48)
(DE91-011523; UCRL-JC-105066; CONF-9010298-10) Avail: NTIS HC/MF A02

Advances in the efficiency and accuracy of computational atomic physics and collisional radiative modeling promise to place the analysis and diagnostic application of L-shell emission on a par with the simpler K-shell regime. Coincident improvements in spectroscopic plasma measurements yield optically thin emission spectra from small, homogeneous regions of plasma, localized both in space and time. Together, these developments can severely test models for high-density, high-temperature plasma formation and evolution, and non-LTE atomic kinetics. In this paper we present highly resolved measurements of n=3 to n=2 x ray line emission from a laser-produced bromine micro-dot plasma. The emission is both space- and time-resolved, allowing us to apply simple, steady-state, 0-dimensional spectroscopic models to the analysis. These relativistic, multi-configurational, distorted wave collisional-radiative models were created using the HULLAC atomic physics package. Using these models, we have analyzed the F-like, Ne-like and Na-like (satellite) spectra with respect to temperature, density and charge-state distribution. This procedure leads to a full characterization of the plasma conditions. DOE

N91-25872# General Atomic Co., San Diego, CA.
EFFECTS OF CURRENT PROFILES ON MHD STABILITY
L. L. Lao, T. S. Taylor, M. S. Chu, A. D. Turnbull, E. J. Strait, J. R. Ferron, and E. A. Lazarus (Oak Ridge National Lab., TN.) Apr. 1991 7 p Presented at the 18th European Conference on Controlled Fusion and Plasma Physics, Berlin, Fed. Republic of Germany, 3-7 Jun. 1991
(Contract DE-AC03-89ER-51114)
(DE91-011742; GA-A-20479; CONF-910609-15) Avail: NTIS HC/MF A02

The magnetohydrodynamic stability of a plasma against the ideal low and high toroidal mode number kink and ballooning modes depends critically on its pressure and current profiles, as well as on the shape of its poloidal cross section, which determines its ability to carry the toroidal current at a given value of edge safety factor q. It has previously been shown that in the absence of finite current density at the edge, the stability of the ideal low toroidal mode number n = 1 kink mode can be substantially improved for broad pressure and peaked current density profiles. With these optimized profiles, kink-stable normalized toroidal beta, beta(sub N) = beta(sub T)/(I/aB(sub T)), near six can be achieved. In the low plasma collisionality regime, significant bootstrap current can be driven which can give rise to high edge current density. In this paper, the effects of current profiles both with and without finite edge current density on the ideal n = 1 kink and infinite n ballooning modes are studied using simulated plasma equilibria with varying beta(sub N), the plasma internal inductance l(sub i), and different amounts of toroidal current density near the edge J(sub S). The study is also motivated by the DIII-D experimental results that beta(sub N) achieved improves with l(sub i). The shape of the toroidal current density profiles is varied using the two parameters l(sub i), which describes its global peakedness, and

J(sub S). The interesting case of negative J(sub S), which can arise in a fast current-ramped down plasma, will be described separately and is nct considered. DOE

N91-25873# Texas Univ., Austin. Inst. for Fusion Studies.
IFS NUMERICAL LABORATORY TOKAMAK
M. J. Lebrun and T. Tajima Mar. 1991 5 p
(Contract DE-FG05-80ET-53088)
(DE91-011832; DOE/ET-53088/483; IFSR-483) Avail: NTIS HC/MF A01

A numerical laboratory of a tokamak plasma is being developed. This consists of the backbone (the overall manager in terms of the MPPL programming language), and the modularized components that can be plugged in or out for a particular run and their hierarchical arrangement. The components include various metrics for overall geometry, various dynamics, field calculations, and diagnoses. DOE

N91-25874# Japan Atomic Energy Research Inst., Tokyo.
EFFECTS OF CURRENT PROFILES ON THE KINK-BALLOONING STABILITY
Takahisa Ozeki, Masafumi Azumi, Shinichi Ishida, Yoshihiko Koide, and Shinji Tokuda (Japan Atomic Energy Research Inst., Ibaraki.) Oct. 1990 21 p In JAPANESE; ENGLISH summary
(DE91-772218; JAERI-M-90-180) Avail: NTIS HC/MF A03

Effects of current profiles on the n=1 kink-ballooning stability in a tokamak are numerically analyzed by the linear ideal MHD stability code, ERATO-J. Stabilities of plasmas with a circular cross-section and peaked pressure profile are analyzed for three types of current profile, i.e., parabolic, flat and hollow profile. In a low beta (epsilon beta(sub p) less than 0.5), the influence of the current profile on the kink-ballooning stability is small, while, in a high beta (epsilon beta(sub p) greater than 0.5), the growth rate of the kink-ballooning mode for the plasma with the hollow current profile becomes larger and the unstable region spreads to the higher q(sub 0) region (q(sub 0) greater than 2). In the JT-60 high beta(sub p) experiments, the beta(sub p) collapse with the fast growth rate (approximately 100 micro-s) was observed with m = 3 mode. The results of the stability analysis of the kink-ballooning mode using the equilibria of JT-60 high beta(sub p) experiments show that the critical beta(sub p) is consistent with the value of beta(sub p) observed in the beta(sub p) collapse. DOE

N91-25875* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PLASMA GUN WITH COAXIAL POWDER FEED AND ADJUSTABLE CATHODE Patent
Isidor Zaplatynsky, inventor (to NASA) 5 Feb. 1991 6 p Filed 7 Jul. 1989 Supersedes N90-10718 (28 - 1, p 126)
(NASA-Case-LEW-14901-1; US-Patent-4,990,739;
US-Patent-Appl-SN-376488; US-Patent-Class-219-121.47;
US-Patent-Class-219-121.52; US-Patent-Class-219-121.48;
US-Patent-Class-219-75; US-Patent-Class-219-76.16;
US-Patent-Class-427-34; Int-Patent-Class-B23K-9/00) Avail: US Patent and Trademark Office CSCL 20I

An improved plasma gun coaxially injects particles of ceramic materials having high melting temperatures into the central portion of a plasma jet. This results in a more uniform and higher temperature and velocity distribution of the sprayed particles. The position of the cathode is adjustable to facilitate optimization of the performance of the gun wherein grains of the ceramic material are melted at lower power input levels.
Official Gazette of the U.S. Patent and Trademark Office

N91-25876# Texas Univ., Austin. Fusion Research Center.
MEASUREMENTS OF PLASMA SPACE POTENTIAL AND RADIAL ELECTRIC FIELD IN TEXT WITH A HEAVY ION BEAM PROBE
X. Z. Yang, P. M. Schoch, R. L. Hickok, and A. J. Wootton May 1990 34 p Prepared in cooperation with Academia Sinica, Beijing, China Sponsored by DOE
(PB91-151290; FRCR-367; DOE/ER-53267/71) Avail: NTIS HC/MF A03 CSCL 20I

A heavy ion beam probe (HIBP) was used to measure plasma potential and radial electric field during Ohmic Heating (OH), high magnetohydrodynamic (MHD), electron cyclotron heating (ECH) and ergodic magnetic limiter (EML) discharges in the Texas Experimental Tokamak (TEXT). A negative central potential phi(0) approx. = -1 kV and a radial electric field E(sub r) approx. = -40 V/cm were observed in ohmically heated plasma. The measured space potential profile is consistent with the ion radial momentum balance equation using experimental values of density and ion temperature, and assuming neoclassical plasma poloidal rotation velocity and no toroidal velocity. With these assumptions, it is expected that phi(sub 0) approx. = (2 to about 2.5) T(sub i)(0). For B(sub T) = 20 kG, I(sub p) = 195 kA OH discharges, the measured phi(sub 0) varies as (n sub e0)(sup 1/3), consistent with Artismovich ion temperature scaling. GRA

N91-25225*# Arizona Univ., Tucson. Dept. of Materials Science and Engineering.
COLD PLASMA PROCESSING OF LOCAL PLANETARY ORES FOR OXYGEN AND METALLURGICALLY IMPORTANT METALS
D. C. Lynch, D. Bullard, and R. Ortega *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 5 p Original contains color illustrations
(For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 20I

76 SOLID-STATE PHYSICS

Includes superconductivity.
For related information, see also *33 Electronics and Electrical Engineering* and *36 Lasers and Masers.*

N91-25877# Technische Univ., Delft (Netherlands).
MODELLING, SYSTEM IDENTIFICATION, AND CONTROL OF AN EVAPORATIVE CONTINUOUS CRYSTALLIZER Ph.D. Thesis
Sjoerd deWolf 1991 263 p Sponsored by Netherlands Foundation of Technology; Akzo Zout Chemie; DOW; DSM/nv Nederlandse Staatsmijnen; Dupont de Nemours (E. I.) and Co.; Rhone-Poulenc Industries; Suiker Unie; Unilever Research
(ISBN-90-370-0043-6; ETN-91-99434) Avail: NTIS HC/MF A12

Research on physical modeling, simulation, the derivation of state space models, suitable input and output variables for control of the crystal size distribution (CSD), and the assessment of experimentally validated models for the dynamics of crytallizers is presented. A 20 liter (L) and a 970 L crystallizer and the measurement system available for online CSD measurements of the 970 L crystallizer are discussed. A general dynamic model for evaporative and nonevaporative continuous crystallizers with fines removal, clear liquor advance and product classification is presented. The model includes nonisothermal operation, size dependent crystal growth rates, growth rate dispersion, and attrition. A simulation technique for the physical model, which was chosen for its close relation to the derivation of state space models and its capability to provide CSD information at fixed time intervals as required for digital control, is discussed. The derivation of linear state space models for the dynamics of crystallizers is investigated. Multivariable control of the 970 L crystallizer is investigated to obtain knowledge of input and output control variables. An experimental model for the 970 L crystallizer is assessed and the necessity for a system identification approach is explained. ESA

N91-25878# Argonne National Lab., IL.
SPUTTERING OF MOLECULES FROM ZnS, CdS, AND FeS2
S. Nikzad (California Inst. of Tech., Pasadena.), W. F. Calaway, M. J. Pellin, C. E. Young, and D. M. Gruen 1990 6 p Presented at the Fall Meeting of the Materials Research Society, Boston, 24 Nov. - 1 Dec. 1990
(Contract W-31-109-eng-38)
(DE91-010279; ANL/CP-71709; CONF-901105-111) Avail: NTIS HC/MF A02

An open question remains as to whether molecules form as a result of simultaneous ejection of neighboring atoms from a solid or because of a molecular band that exists in the solid metal target before sputtering. This was addressed by sputtering experiments using a binary target, where the constituents of the sputtered molecules may not occupy nearest neighbor sites in the crystal. A study was conducted on single crystals of three metal-sulfides with two different lattice structures, using laser post-ionization mass spectrometry to detect neutral sputtered species. The single crystals used for these experiments were synthetically grown CdS and ZnS with the Wurtzite structure, and natural FeS2 with the cubic structure. The FeS2 samples were ultrasonically cleaned with trichloroethane, acetone, and methanol before insertion in the UHV chamber. The latter two solvents were used to clean CdS and ZnS. In sputtering metal sulfides of different structures, sputtered molecules with constituents that do not have a bond in the solid were observed. In the case of the metal dimers, the sputtered atom exceeds in number the metal dimer, whereas S is predominantly sputtered as S2 from all three samples. The results presented in this paper also suggest that some form of recombination mechanism (inside or outside the solid) is responsible for formation of molecules. Our data also show that the sputtered molecules form a significant percentage of the sputtered species. Therefore, it is important for quantitative analyses to obtain an accurate measure of molecular sputtering yields. DOE

N91-25879# Brookhaven National Lab., Upton, NY.
TEXTURED GROWTH PROCESSING OF HTSC IN THE Y-Ba-Cu-O
H. Wang, H. Herman (State Univ. of New York, Stony Brook.), and J. Orehotsky 1991 13 p Presented at the Annual Meeting and Exhibition of the Minerals, Metals and Materials Society (TMS), New Orleans, 17-21 Feb. 1991
(Contract DE-AC02-76CH-00016)
(DE91-010367; BNL-45894; CONF-910202-9) Avail: NTIS HC/MF A03

A process for achieving textured growth has been applied to the high (Tc) superconductor, YBa2Cu3O(7-x) (123), formed by either plasma-spraying or cold pressing and sintering. The free standing plasma-sprayed deposits, removed from the substrates, were partially melted in a zone heating apparatus. The surfaces of the deposits exhibited aligned grains nearly parallel to the direction of growth in the heated zone. X-ray diffraction of the surfaces revealed a strong preferred orientation in the (001) direction. The critical current density exceeded 5 times 10(exp 3) A/sq cm in an applied field of 1 or 2 Tesla at 77 K. Plasma sprayed coatings were also deposited on nickel substrates covered with a zirconia barrier layer. Although the critical current density of these coatings was substantially lower than that of the free standing plasma sprayed deposits, the zirconia buffer layer facilitated the grain alignment of the 123 coatings. A large variation was observed in the critical current densities of the textured specimens from the sintered bulk pellets. Differences were also observed among commercial powders with the same apparent starting composition. DOE

N91-25880# Oak Ridge National Lab., TN.
CASTING OF HgCdTe
V. Alexiades (Oak Ridge National Lab., TN.) Mar. 1991 24 p
(Contract DE-AC05-84OR-21400)
(DE91-010683; ORNL/TM-11753) Avail: NTIS HC/MF A03

HgCdTe is a technologically important electronic material for which large crystals of uniform composition are desirable. This is very difficult to achieve when the crystal is grown under gravity, so it is important to understand the details of the crystal growth process both qualitatively and quantitatively. The first stage is presented of the effort towards a detailed macroscopic model of the casting process, and its numerical simulation: the basic coupled conduction-diffusion model of the solidification process with constitutional supercooling and its numerical implementation. A compilation of all the revelant thermophysical properties of the pseudo-binary HgTe(1-x)CdTe(x), as functions of composition x and temperature, is presented in Part 1. DOE

N91-25881# Oak Ridge National Lab., TN.
CASTING OF HgCdTe
V. Alexiades (Oak Ridge National Lab., TN.) Mar. 1991 19 p
(Contract DE-AC05-84OR-21400)
(DE91-010724; ORNL/TM-11734) Avail: NTIS HC/MF A03

Mercury-Cadmium-Telluride is a technologically important electronic material, used primarily as an infrared-detector. In such applications, large crystals of uniform concentration are desirable, which is difficult to achieve when the crystal is grown under gravity. Modeling and numerical simulation can help us gain insight, in the interpretation of experiments, and in designing future earth-bound and microgravity experiments. In this report we present a compilation of the relevant thermophysical properties of the pseudo-binary (HgTe)(1-x)(CdTe)(x), as functions of composition, x, and temperature, for both the solid and liquid phases, at the high temperatures (approximately 600 to 1100 C) relevant in the casting process. DOE

N91-25882# Brookhaven National Lab., Upton, NY.
SLOW POSITRON STUDIES OF HYDROGEN ACTIVATION/PASSIVATION ON SiO2/Si(100) INTERFACES
K. G. Lynn and P. Asoka-Kumar 1991 10 p Presented at the Japan Atomic Energy Research Institute (JAERI) Workshop on Positron Spectroscopy, Tokyo (Japan), 28 Feb. - 1 Mar. 1991
(Contract DE-AC02-76CH-00016)
(DE91-010974; BNL-45987; CONF-910284-3) Avail: NTIS HC/MF A02

The hydrogen atoms are one of the most common impurity species found in semiconductor systems owing to its large diffusivity, and are easily incorporated either in a controlled process like in ion implantation or in an uncontrolled process like the one at the fabrication stage. Hydrogen can passivate dangling bonds and dislocations in these systems and hence can be used to enhance the electrical properties. In a SiO2/Si system, hydrogen can passivate electronic states at the interface and can alter the fixed or mobile charges in the oxide layer. Since hydrogen is present in almost all of the environments of SiO2/Si wafer fabrication, the activation energy of hydrogen atoms is of paramount importance to a proper understanding of SiO2/Si based devices and has not been measured on the technologically most important Si(100) face. There are no direct, nondestructive methods available to observe hydrogen injection into the oxide layer and subsequent diffusion. The positrons are used as a 'sensitive', nondestructive probe to observe hydrogen interaction in the oxide layer and the interface region. A new way is described of characterizing the changes in the density of the interface states under a low temperature annealing using positrons. DOE

N91-25883# Oak Ridge National Lab., TN.
SURFACE STRUCTURES AND THE ORTHORHOMBIC TRANSFORMATION OF THIN FILM BaSi2 ON SILICON
R. A. McKee, F. J. Walker, and J. R. Conner (Oak Ridge Associated Universities, Inc., TN.) 1991 6 p Presented at the Spring Meeting of the Materials Research Society (MRS), Anaheim, 29 Apr. - 3 May 1991
(Contract DE-AC05-84OR-21400)
(DE91-011372; CONF-910406-2) Avail: NTIS HC/MF A02

The epitaxial structural development and surface reactions of barium metal with silicon have been studied as a function of surface coverage. BaSi2 is orthorhombic, and grows epitaxially on Si(001) and Si(111) for surface coverages greater than 1 monolayer (ML). From 0 to 1 ML a series of ordered surface structures develops that suggests a cubic Ba-Si compound. Reflection high energy electron diffraction (RHEED), Auger and x-ray photoelectron spectroscopy (XPS) data have been obtained in this thin film regime that support a chemical reaction and compound formation between barium and silicon for all barium coverages. In bulk form, at high pressures, BaSi2 can be stabilized into the cubic SrSi2 structure. We suggest that epitaxial strain at the silicon surface provides a

mechanism for stabilizing the low-coverage precursors of the orthorhombic BaSi2. DOE

N91-25884# California Univ., Berkeley. Lawrence Berkeley Lab.
MICROSTRUCTURE AND ELECTROMIGRATION EFFECTS IN Al AND Al ALLOY THIN FILMS Ph.D. Thesis
J. E. Sanchez, Jr. Jan. 1991 132 p
(Contract DE-AC03-76SF-00098)
(DE91-011864; LBL-30277) Avail: NTIS HC/MF A07

The evolution of the microstructure of sputtered Al and Al-2 percent Cu thin films and interconnects has been studied as a function of thermal treatments and accelerated electromigration testing. Transmission electron microscopy (TEM), scanning electron microscopy (SEM), and focussed ion beam (FIB) orientation contrast techniques were used for detailed microstructural analyses of median grain size, grain size distribution, precipitate size and morphology, and electromigration induced voids and hillocks in planar thin films and patterned conductors. The as-deposited Al grain size was shown to be a function of deposition time and substrate heating during deposition. Thermally activated Al grain growth during anneals between 345 and 472 C for 5 and 15 minutes produced a kinetic growth parameter of 1/8. This low rate process was described as due to saturated growth for these annealing conditions. All grain distributions studied were found to be lognormally distributed, independent of annealing conditions. As a result of these anneals, CuAl2 (theta phase) precipitate morphologies were categorized into two main types. At the higher anneal temperatures, complete theta phase dissolution at temperature and subsequent heterogeneous precipitation on cooling produced elongated theta particles along grain boundaries. Alternately, at 345 C and below, a blocky theta phase at grain triple points was produced by Ostwald coarsening during the anneal process. The results of a theta phase coarsening study at 310 C included a kinetic rate parameter of approximately 1/3 to 1/4. This was described as characteristic of boundary particle coarsening where the diffusion pathways are grain boundaries. DOE

N91-25885# Argonne National Lab., IL.
PREPARATION AND CHARACTERIZATION OF YBa2Cu4O8 SUPERCONDUCTOR
U. Balachandran, Y. Li, Y. Gao, K. L. Merkle, H. Shi, and R. B. Poeppel Jan. 1991 20 p Presented at the 2nd International Ceramic Science and Technology Congress, Orlando, 12-15 Nov. 1990
(Contract W-31-109-eng-38)
(DE91-010596; ANL/CP-70570; CONF-901125-13) Avail: NTIS HC/MF A03

Solid-state reaction of appropriate amounts of Y2O3, BaCO3, and CuO for 2 h at 800 C in flowing oxygen with a total pressure of 2.7 x 10(exp 2) Pa, followed by cooling and annealing at 750 C for 10 h in oxygen at ambient pressure, has produced orthorhombic YBa2Cu4O8 (124) as the main phase with YBa2Cu3O(x) (123) as an impurity phase. After the as-calcined powder was annealed in oxygen at 800 C for 24 h under ambient pressure, the phase purity improved considerably. Calcined 124 powder was pressed into pellets and rapidly annealed at temperatures from 870 C to 935 C. At these temperatures, the 124 decomposed into 123. The superconducting transition temperature of the annealed samples depended upon the annealing temperature and atmosphere. The decomposed samples have been characterized by low field RF SQUID magnetometer and high resolution transmission electron microscopy. DOE

N91-25886# Rochester Univ., NY.
FEMTOSECOND STUDIES OF SURFACE ELECTRON TRANSFER PROCESS AT SEMICONDUCTOR INTERFACES
R. J. D. Miller 1990 21 p
(Contract DE-FG02-85ER-13455)
(DE91-010914; DOE/ER-13455/4) Avail: NTIS HC/MF A03

The primary focus of this research was to develop new spectroscopies applicable to the study of carrier dynamics at semiconductor surfaces. The progress made during the tenure of this grant includes the development of three techniques for surface studies: Surface Restricted Transient Grating Spectroscopy, Surface Acoustic Wave (SAW) spectroscopy, and Surface Space-charge Electro-optic Sampling. Further, these techniques were then applied to the study of carrier dynamics at n-TiO2 and n-GaAs interfaces. The primary results were that hole carrier reaction dynamics at TiO2 surfaces involves thermalized hole carriers at the surface on 100 psec time scales. A large effective hole mass of TiO2 is found m(sub h) greater than 3m, which negates any possibility of hot hole transfer. In contrast, the studies at n-GaAs (100) surfaces found hole carrier transfer to be faster than 30 psec and appears to be direct, without the intermediacy of surface states. The hole carrier transport to the surface is found to be faster than 300 fsec and approaches the ballistic limit for transport. Therefore, the hole carriers do arrive with large amounts of excess energy at the surface. These results indicate that at least some fraction of the hole carriers are transferring unthermalized. The importance of this in solar energy collection is that this work supports, at least from a fundamental standpoint, the possibility of exploiting hot carriers to avoid thermal energy loss mechanisms and enhance conversion efficiency. These studies are the first to provide direct time resolved (not diffusion limited) studies of surface reaction dynamics. In addition, the approach provides the highest possible resolution for studying surface reactions in the time domain. The specific results for both TiO2 and GaAs surface is discussed. DOE

N91-25887# EIC, Inc., Norwood, MA.
SOLID STATE ELECTROCHROMIC SMART WINDOWS
Mar. 1991 33 p
(Contract DE-AC03-87SF-16733)
(DE91-011026; DOE/SF-16733/T1) Avail: NTIS HC/MF A03

The structure under development at EIC Laboratories consists of a multilayer stack of thin films, incorporating the two principal electrochemically active elements, the electrochromic (EC) and counter electrode (CE) layers, respectively. The EC layer changes from colorless to a state of reduced transmission on reduction while the CE layer has the opposite (complementary) behavior (or is colorless in both oxidized and reduced states). These are separated by an ion conducting electrolyte. The stack is completed with top and bottom transparent electrodes. The major achievements are as follows: (1) Tunable thermal emittance for the EC layer over a range of 0.2 to 0.8 was demonstrated, indicating the feasibility of surfaces with adjustable heat transfer properties. (2) Thin film ion conductors based on the Li2O/B2O3 and LiNbO3 were developed using thermal and electron beam evaporation with ionic conductivities greater than 10(exp -8) S/cm, fulfilling a major requirement for this component. (3) A variety of improved vanadium oxide-based counter electrode materials were demonstrated and patented which undergo reversible electrochemical Li insertion reactions and which increase their solar transmission on reduction. (4) Devices incorporating a laminated Li+ conducting polymer electrolyte were demonstrated with bleached state visible transmittance of greater than 65 percent and colored state transmittance of less than 15 percent. These devices were tested for greater than 10(exp 4) complete cycles. (5) An all thin film solid state device was demonstrated with a visible transmission range of 65/13 percent, using the component materials developed on this program. The device was tested for greater than 3000 complete cycles without degradation. A fabrication sequence was specified which forms the basis of initial production cost estimates. (6) Window modeling studies have been used to compare the relative performance of amorphous and crystalline WO3-based electrochromic structures. DOE

N91-25888# Argonne National Lab., IL.
SUPERCONDUCTING FILMS MADE BY SPIN-COATING OF ACETATE SOLUTIONS
U. Balachandran, R. B. Poeppel, D. I. dosSantos, C. L. Carvalho, R. R. daSilva, and M. A. Aegerter (Sao Paulo Univ., Sao Carlos, Brazil) Dec. 1990 13 p Presented at the 2nd International Ceramic Science and Technology Congress, Orlando, 12-15 Nov. 1990

(Contract W-31-109-eng-38)
(DE91-011119; ANL/CP-72125; CONF-901125-15) Avail: NTIS HC/MF A03

Metallic silver substrates were spin-coated with several layers of mixed acetate solutions containing bismuth, lead, strontium, calcium, and copper. The viscosities of the cation solutions were modified by the addition of polyvinyl alcohol. The films were heat treated at various temperatures in air, O2, and 1 percent O2 (balance N2) atmospheres. Bismuth cuprate films with transport critical current densities (approximately 500 A/sq cm) were obtained in this work. New conditions of coating and sintering have been tried to produce superconducting films. DOE

N91-25889# Argonne National Lab., IL.
ENHANCED FLUX PINNING BY CRYSTAL DEFECTS IN MELT-TEXTURED YBa2CuO(x)
D. Shi, K. C. Goretta, S. Salem-Sugui, Jr., and J. G. Chen (Illinois Univ., Urbana.) 1991 11 p Presented at the Annual Meeting and Exhibition of the Minerals, Metals and Materials Society (TMS), New Orleans, 17-21 Feb. 1991
(Contract W-31-109-eng-38)
(DE91-011120; ANL/CP-72496; CONF-910202-10) Avail: NTIS HC/MF A03

YBa2Cu3O(x) bars were partially melted to develop highly textured microstructures. Transmission electron microscopy (TEM) revealed the presence of a large amount of intragranular defects such as dislocations and stacking faults, and a few Y2BaCuO5 particles, within the matrices. These crystal defects strongly affected intragranular J(sub c) values and the flux-creep behavior. After annealing the textured samples at high temperature for 80 h, considerable reduction in the magnetization J(sub c) was observed. This microstructure-related J(sub c) variation indicated that the lattice defects observed by TEM were connected with the observed enhanced flux pinning. Possible pinning mechanisms are discussed. DOE

N91-25890# Argonne National Lab., IL.
PREPARATION OF YBa2Cu3O(x) SUPERCONDUCTOR VIA TERNARY PRECURSORS
U. Balachandran, R. A. Russell, S. L. Morissette, T. J. Brent, and R. B. Poeppel Mar. 1991 11 p Presented at the 2nd International Ceramic Science and Technology Congress, Orlando, 12-15 Nov. 1990
(Contract W-31-109-eng-38)
(DE91-011121; ANL/CP-70597; CONF-901125-16) Avail: NTIS HC/MF A03

The YBa2Cu3O(x) (123) superconductor was prepared by a new method using the ternary precursors BaCuO2 and Y2Cu2O5. The BaCuO2 is prepared by calcining a mixture of BaCO3 and CuO at a temperature of approx. 850 C in flowing oxygen at reduced total pressure, followed by ambient pressure heating at approx. 925 C. The Y2Cu2O5 is synthesized by a solid state reaction between Y2O3 and CuO in ambient pressure at approx. 950 C. A stoichiometric mixture of BaCuO2 and Y2Cu2O5 is heated to approx. 950 C to form 123. The reaction between Y2Cu2O5 and BaCuO2 is very fast and results in nearly phase-pure 123 in a short period. DOE

N91-25891# Argonne National Lab., IL.
STRENGTH/GRAIN-SIZE RELATIONSHIPS AND INTERNAL STRESSES IN YBa2Cu3O(x) SUPERCONDUCTORS
J. P. Singh, R. A. Guttschow, D. S. Kupperman, J. T. Dusek, and R. B. Poeppel 1991 15 p Presented at the Annual Meeting and Exhibition of the Minerals, Metals and Materials Society (TMS), New Orleans, 17-21 Feb. 1991
(Contract W-31-109-eng-38)
(DE91-011180; ANL/CP-71113; CONF-910202-11) Avail: NTIS HC/MF A03

Extruded wires of YBa2Cu3O(x) (YBCO) superconductors were sintered at various temperatures and oxygen partial pressures for different times to obtain different microstructures. A decrease in average grain size from approximately 23 to approximately 4 microns resulted in a corresponding increase in strength from approximately 85 to approximately 195 MPa. The increase in strength with decreasing grain size results from a decrease in the residual tensile stresses due to grain anisotropy. These results are consistent with the variation of internal residual strain with grain size measured by a neutron diffraction technique. DOE

N91-25892# Oak Ridge National Lab., TN.
MICROSCOPY OF SEMICONDUCTING MATERIALS
S. J. Pennycook 26 Apr. 1991 13 p
(Contract DE-AC05-84OR-21400)
(DE91-011197; ORNL/FTR-3884) Avail: NTIS HC/MF A03

The purpose of the trip was to present an invited talk at the 7th Oxford Conference on Microscopy of Semiconducting Materials entitled, High-Resolution Z-Contrast Imaging of Heterostructures and Superlattices, (Oxford, United Kingdom) and to visit VG Microscopes, East Grinstead, for discussions on the progress of the Oak Ridge National Laboratory (ORNL) 300-kV high-resolution scanning transmission electron microscope (STEM), which is currently on order. The traveler also visited three other institutions with 100-kV STEMs that either have or intend to purchase the necessary modifications to provide Z-contrast capability similar to that of the existing ORNL machine. Specifically, Max-Planck Institut fuer Metallforschung (Stuttgart, Germany); Cambridge University, Department of Materials Science and Metallurgy (Cambridge, United Kingdom); and Cavendish Laboratory, Cambridge University (Cambridge, United Kingdom) were visited. In addition, discussions were held with C. Humphreys on the possibility of obtaining joint funding for collaborative research involving electron beam writing and Z-contrast imaging in the Cambridge and Oak Ridge STEMs, respectively. DOE

N91-25893# Sandia National Labs., Albuquerque, NM.
COMPUTATIONAL FLUID DYNAMICS FOR DEFECT CONTROL IN SEMICONDUCTOR PROCESSING
S. N. Kempka and A. S. Geller 1991 20 p Presented at the 4th FIDAP Users Conference, Evanston, 14-16 Apr. 1991
(Contract DE-AC04-76DP-00789)
(DE91-011234; SAND-90-2739C; CONF-9104202-3) Avail: NTIS HC/MF A03

Finite element simulations of mixed convection flow (Re less than 100, Gr less than 10(exp 6)) are presented for two gas flow reactors characteristic of those used in the manufacture of microchips. The simulations demonstrate the usefulness of FIDAP (a finite element, Navier-Stokes code developed by Fluid Dynamics International, Inc.) as a tool to design new reactors and to assess the effects of varying operating conditions in present reactors. The calculations predict the existence of thermal plumes and recirculation regions within reactors. These flow nonuniformities are important since they can result in fatal defects in microchips. Comparisons between solutions obtained using a Boussinesq model and FIDAP's variable density model are presented. The FIDAP calculations agree with previous simulations using more detailed models, supporting the use of FIDAP as a design tool in the semiconductor industry. DOE

N91-25894# Los Alamos National Lab., NM.
CONNECTIONS BETWEEN MAGNETISM AND SUPERCONDUCTIVITY IN UBe13 DOPED WITH THORIUM OR BORON
R. H. Heffner, H. R. Ott, A. Schenck, J. A. Mydosh, and D. E. MacLaughlin Jun. 1991 24 p Presented at the 5th Joint Magnetism and Magnetic Materials (MMM/INTERMAG) Conference, Pittsburgh, 18-21 Jun. 1991
(Contract W-7405-eng-36)
(DE91-011416; LA-UR-91-1381; CONF-910608-1) Avail: NTIS HC/MF A03

Magnetism and superconductivity appear to be intimately connected in the heavy electron (HE) superconductors. For example, it has been conjectured but not proven that the exchange of antiferromagnetic spin fluctuations are responsible for pairing in HE superconductors. In this paper we review recent results in U(1-x)Th(x)Be(13), where specific heat, lower critical field and

zero-field (mu)SR measurements reveal another second-order phase transition to a state which possesses small-moment magnetic correlations for 0.019 (le) (times) (le) 0.043. We present a new phase diagram for (U,Th)Be(13) which indicates that the superconducting and magnetic order parameters are closely coupled. A discussion of the nature of the lower phase is presented, including the consideration of a possible magnetic superconducting state. When UBe(13) is doped with B (UBe(12.97)B(0.03)) the Kondo temperature is decreased and the specific heat jump at the superconducting transition temperature is significantly enhanced. However, (mu)SR measurements reveal no magnetic signature in UBe(12.97)B(0.03), unlike the case for Th doping. The correlation between changes in the Kondo temperature and changes in the superconducting properties induced by B doping provide evidence for the importance of magnetic excitations in the superconducting pairing interaction in UBe(13). DOE

N91-25895# Argonne National Lab., IL.
CRITICAL CURRENT AND FLUX PINNING BY CRYSTAL DEFECTS IN MELT-TEXTURED YBa2Cu3O(x)
Donglu Shi, K. C. Goretta, J. G. Chen, and A. C. Biondo 1990 15 p Presented at the 2nd International Ceramic Science and Technology Congress, Orlando, 12-15 Nov. 1990
(Contract W-31-109-eng-38)
(DE91-011749; ANL/CP-72075; CONF-901125-17) Avail: NTIS HC/MF A03

Sintered YBa2Cu3O(x) bars 50 mm in length have been partially melted to develop highly textured microstructures. The bars exhibited large magnetic hysteresis and transport J(sub c) values relative to conventional bulk YBa2Cu3O(x). Transmission electron microscopy observations revealed unique grain boundary features which are likely to be responsible for reduced weak-link effects. A high concentration of dislocations and some Y2BaCuO5 particles were present in sample matrices. After high-temperature annealing, the intragranular J(sub c) of the melt-textured material was considerably reduced. This reduction in J(sub c) suggested that crystal defects such as dislocations were responsible for the stronger flux pinning in the melt-textured samples. DOE

N91-25896# California Univ., Berkeley. Lawrence Berkeley Lab.
INTERFACIAL REACTIONS BETWEEN THIN FILMS OF Co AND InP(100)
M. Ben-Tzur, K. M. Yu, and E. E. Haller Nov. 1990 8 p Presented at the Fall Meeting of the Materials Research Society (MRS), Boston, 24 Nov. - 1 Dec. 1990
(Contract DE-AC03-76SF-00098)
(DE91-011910; LBL-29270; CONF-901105-120) Avail: NTIS HC/MF A02

The interfacial reactions between thin films of Co and single crystal InP have been studied. The reaction between the Co and the InP substrate already start in the as-deposited state to form In and P rich compounds. During annealing at 250 C for 30 min., phase separation takes place. In addition to unreacted Co, we find Co rich compounds, a Co-P compound in contact with the substrate, and Co-In compound in contact with the metal layer. The general morphology appears to be stable up to 500 C. At higher temperatures (500 to 600 C) P is released from the substrate. CoP4, Co2P, CoIn2, and In were detected by x-ray diffraction. At this stage the reaction is no longer uniform. DOE

N91-25797*# National Inst. of Standards and Technology, Boulder, CO. Time and Frequency Div.
ENVIRONMENTAL SENSITIVITIES OF QUARTZ CRYSTAL OSCILLATORS
Fred L. Walls *In* JPL, The 22nd Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting May 1990 p 465-486 (For primary document see N91-25755 17-70)
Avail: NTIS HC/MF A99 CSCL 20L

N91-25933*# George Mason Univ., Fairfax, VA. Dept. of Electrical and Computer Engineering.
GALLIUM ARSENIDE PROCESSING FOR GATE ARRAY LOGIC Abstract Only
Eric D. Cole *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 31 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 20L

77 THERMODYNAMICS AND STATISTICAL PHYSICS

Includes quantum mechanics; theoretical physics; and Bose and Fermi statistics.

For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer.*

N91-25897# North Carolina Univ., Chapel Hill. Dept. of Physics.
RESEARCH IN THEORETICAL PHYSICS
H. VanDam 1991 34 p
(Contract DE-FG05-85ER-40219)
(DE91-010744; DOE/ER-40219/5) Avail: NTIS HC/MF A03

Short summaries are presented of research in conformal field theory, standard model, p-adic physics, cosmology constant, and other theoretical physics topics. DOE

N91-25898# Kyoto Univ., Uji (Japan). Inst. for Theoretical Physics.
MODULI SPACE OF CHERN-SIMONS GRAVITY
Jiro Soda and Yuki Yamanaka (Hiroshima Univ., Japan) Sep. 1990 13 p
(DE91-772178; YITP/U-90-19) Avail: NTIS HC/MF A03

Conformally invariant (2+1)-dimensional gravity, Chern-Simons gravity, is studied. Its solution space, moduli space, is investigated using the linearization method. The dimension of moduli space is determined as 18g - 18 for g greater than 1, 6 for g = 1, and 0 for g = 0. We discuss the geometrical meaning of our investigation. DOE

80 SOCIAL SCIENCES (GENERAL)

Includes educational matters.

N91-25899# General Accounting Office, Washington, DC.
SHORTAGES OF SCIENTISTS AND ENGINEERS DUE TO RETIREMENTS UNLIKELY IN THE 1990S
Jun. 1991 30 p
(GAO/NSIAD-91-185) Avail: NTIS HC/MF A03

The increasing number of scientists and engineers eligible for retirement at the NASA and the impact of this situation on NASA's work force in the 1990s are addressed. The information provided on April 11, 1990 is summarized. Author

81 ADMINISTRATION AND MANAGEMENT

Includes management planning and research.

N91-25900# Technische Univ., Delft (Netherlands).
PROFILES IN MANAGEMENT: RELATIONS IN THE MARKET AND BUSINESS PLACE Ph.D. Thesis
Willem Gerrit Monhemius 1990 305 p
(ETN-91-99436) Avail: NTIS HC/MF A14

The control of business systems is addressed. This is seen against a background of a society in continual flux. The aspects that play a role in this respect are investigated, not as independent, unconnected elements, but in their mutual relation. No common tenet was found and reasons for this are given. The aim is to unfold the problems and indicate the passage from

entrepreneurship to running a company on full stream. It is found that on the basis of experience, the heads of small companies, who have had practice at their schools, often have a more businesslike attitude and frame of mind than those who have followed an appropriate training. ESA

N91-25901# Department of Energy, Washington, DC. Office of Program Analysis.
PROCEDURES FOR PEER REVIEW ASSESSMENTS
Apr. 1991 35 p
(DE91-010902; DOE/ER-0491P) Avail: NTIS HC/MF A03

These assessment procedures provide the basis for implementing the methodology developed by the Office of Program Analysis (OPA) for assessing the quality of research and development within the Department of Energy (DOE). The reviews are performed by examining individual projects which comprise a program and by assessing the quality of the research, quality of the research team, productivity, probability of success, and mission relevance for each project reviewed. OPA's methodology entails assembling panels of scientific and technical experts to evaluate individual projects. Inferences about the quality of the overlying program emerge from analysis of the ratings given all of the program's individual projects or, in the case of a large program, statistical analysis of a properly drawn sample of individual research projects. DOE

82 DOCUMENTATION AND INFORMATION SCIENCE

Includes information management; information storage and retrieval technology; technical writing; graphic arts; and micrography.

For computer documentation see *61 Computer Programming and Software.*

N91-25902# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Technical Information Panel.
BRIDGING THE COMMUNICATION GAP
Feb. 1991 122 p In ENGLISH and FRENCH Meeting held in Trondheim, Norway, 5-6 Sep. 1990
(AGARD-CP-487; ISBN-92-835-0604-9) Copyright Avail: NTIS HC/MF A06; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The proceedings of the meeting are presented. Topics discussed include the following: optical media, computers assisted publishing, broader communication bands, natural language processing and machine translation, full text retrieval, intelligent on-line interfaces, full text indexing and retrieval, the problems faced by data base publishers, and the training of information specialists. The final paper suggests actions that might be taken by information center managers, and recommendations they might make to ministries and other official bodies. For individual titles, see N91-25903 through N91-25913.

N91-25903# Technical Univ. of Norway, Trondheim.
AN OVERVIEW OF OPTICAL MEDIA NOW AND IN THE FUTURE
R. Storleer *In* AGARD, Bridging the Communication Gap Feb. 1991 8 p (For primary document see N91-25902 17-82)
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The Optical Technology Family is examined, where the different members of the analog, hybrid and digital optical storage groups are presented. The different media have both advantages and disadvantages. Analog storage has up to the present been the only medium for storage and presentation of pictures and films with high quality. By digitalization of pictures, each picture needs from 0.3 to 1.0 Mbyte depending on the quality. That means that a CD-ROM only can keep about 7 to 900 color pictures and only 25 to 35 seconds film presentation. A videodisk can keep more than 100,000 pictures which gives about one hour film presentation. Manufacturers are working hard to solve this problem by finding new comprimation algorithms. The presentation deals with the different types: LaserVision, RID, WORM, DRAW, CD-ROM, CD-ROM-XA, DVI, CD-I, Erasables, etc. What about storage capacity, which type of matter is useful to store on what media, existing standards, use and miscellaneous, future prospects etc. The main emphasis is on CD-ROM which is the most common used optical media in a library environment. Author

N91-25904# Springer-Verlag G.m.b.H. and Co. K.G., Heidelberg (Germany, F.R.).
COMPUTER-ASSISTED PUBLISHING WITH ITS STANDARDS AND COMPATIBILITY PROBLEMS
Holger Wendt and Christine Zuern *In* AGARD, Bridging the Communication Gap Feb. 1991 2 p (For primary document see N91-25902 17-82)
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The original task of a publishing house, that is, to publish information in printed form, has changed enormously during the past few years. The possibilities offered by electronic data processing have several effects: on the one hand, more and more authors are choosing to write their manuscripts on word processing systems and send them to the publishing house on data carriers or by electronic mail. On the other hand, the possibility of using one text for several purposes has increasingly led to information being published on new media. These options are briefly examined. Author

N91-25905# Technical Univ. of Norway, Trondheim.
BROADER COMMUNICATION BANDS **c32**
Gunnar Stette *In* AGARD, Bridging the Communication Gap Feb. 1991 10 p (For primary document see N91-25902 17-82)
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Telecommunications is transportation of information. Before discussing the capacities of the emerging transportation system for this type of goods, different services are examined and a set of references are established, both for volume of information, which is expressed in bits or Megabits, and for information transfer rates or channel capacities, which is expressed in bits per second, (bit/s). The highways for information, the broadband communications channels and systems are studied, and this means systems where the transmission requires a considerable higher bandwidth or bit rate than what can be accomplished via the ordinary analogue telephone system. Materials for broadband communication include data files, high resolution graphics (including 3-D and animated graphics), documents or images, and moving pictures. Broadband communications will extend the prominent role the image now plays in newspapers, books, brochures, slides and business sector. Author

N91-25906# Copenhagen Univ. (Denmark).
FIELDS OF APPLICATION OF THE PROCESSING OF NATURAL LANGUAGES WITH THE HELP OF ARTIFICIAL INTELLIGENCE **c63**
Bente Maegaard *In* AGARD, Bridging the Communication Gap Feb. 1991 5 p (For primary document see N91-25902 17-82)
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Two very important areas of Natural Language Processing (NLP) application are described in some detail, machine translation and computer assisted instruction. Both fields are extremely important, and of growing importance. Artificial Intelligence techniques are only starting to be used in applications. At the same time an alternative model for artificial intelligence has emerged: neural networks. Neural networks are interesting from a theoretical point of view, because they can be said to take into account the biology of human information processing. It is not possible at present to evaluate the potential of neural networks for application in the Language Industries. Author

N91-25907# Bell Communications Research, Inc., Morristown, NJ.
FULL TEXT RETRIEVAL WITH GRAPHICS
Michael Lesk *In* AGARD, Bridging the Communication Gap Feb. 1991 13 p (For primary document see N91-25902 17-82)
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Conventional full text retrieval systems often omit the pictures from the material they display. The existing machine-readable text of the American Chemical Society journals were scanned from microfilm and the images were extracted from the text by algorithms which analyze the digitized bitmaps. The combined pictoral and text material is used with full-text search to provide access to the complete file. The major experiments to be done are to: (1) measure the acceptability of the electronic systems; (2) compare full text search of titles, abstracts and/or indexing; and (3) compare presentation of full page images in bitmap format, presentation of text in ASCII with graphics on demand from images, and traditional paper copies of the journals. The major parts of the research are: (1) Software to partition digitize images of pages into textual, tabular and pictorial areas, (This is used to extract the graphics material, which is then matched with the commands referencing the pictures in the typesetting tapes, and prepared for display as bitmaps); (2) Search software which implements conventional searching capability (Boolean and coordinate index term search) on the full text of the journals, which is available from the typesetting and on-line operations of the American Chemical Society, (Experiments are also continuing with the use of singular value decomposition to group documents and concepts to aid searching); and (3) Browsing and reading software to help people read complex journal material on-line, by highlighting matches, formatting paragraphs, and providing interactive screen displays. Author

N91-25908# Commission of the European Communities (Luxembourg). Computerized Language Processing Unit.
BEYOND MACHINE TRANSLATION
L. Rolling *In* AGARD, Bridging the Communication Gap Feb. 1991 6 p (For primary document see N91-25902 17-82)
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The essential aspects are described of computer translation: design, funding, development, experimental use, evaluation and implementation. The technical, economic, and psychological obstacles to be overcome for efficient use of the new instrument are emphasized. Current applications will be supplemented by other, new applications in the Machine Translation (MT) market, which may well be centered on commercial communication and data base access. While the technical feasibility and the economic viability of MT depend on system design and implementation infrastructure, the quality of MT output ultimately depends on the representativity of available grammars and dictionaries vis-a-vis the real life use of human language. But MT is not the only application that requires a complete mastery of a number of languages by computer. Publishing, data base maintenance and interrogation, and many other natural language processing activities require all-encompassing text corpora, multi-purpose lexica, term banks and other linguistic and computational resources. The EC commission has a major role to play in the coordination of European efforts to standardize, develop and manage these resources, to be used also for speech-technology and knowledge based applications of the future. EC action includes a number of ESPRIT and IMPACT projects, but the coordinating and teaching tasks, now under the Commission's Multilingual Action Plan, may well be handled by a new agency to be created for this purpose. Author

N91-25909# Tome Associates Ltd., London (England).
THE ROLE OF INTELLIGENT ONLINE INTERFACES TO BRIDGE THE COMMUNICATION GAP c32
A. Vickery *In* AGARD, Bridging the Communication Gap Feb. 1991 9 p (For primary document see N91-25902 17-82)
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A great deal of technical and professional communication today, is mediated through documents, or even more indirectly, through computer systems. Communication gaps between man and system are just as real and important as any other, and it is this kind of gap that is considered. The difficulties are listed which arise in accessing computer-based information: (1) the language barriers such as databases in different national languages, concepts having different meanings in different databases (or parts of the same database), variations in command or query languages; (2) the intellectual difficulties, i.e., the gap in knowledge which exists in the searcher's mind during the stage of search formulation, the misunderstandings which can arise during the human/human communication (if the search is done by an intermediary), and errors arising from human/computer communication during the search process; and (3) the technical barriers in achieving a satisfactory search result, i.e., in communication with various hosts and many databases, in using telecommunication links, in different techniques in interrogating files, in different indexing methods, in variations in structure of vocabularies, in classification. The current achievements in overcoming the barriers to information for online databases and the problems which still need solutions are summarized. Author

N91-25910# American Inst. of Aeronautics and Astronautics, New York, NY.
DATABASE PUBLISHERS' CHALLENGES FOR THE FUTURE
Barbara Lawrence *In* AGARD, Bridging the Communication Gap Feb. 1991 10 p (For primary document see N91-25902 17-82)
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The role of database publishers is analyzed. As an aid to achieving this focus, some recent words from Everett Brenner, long a gadfly of the database and secondary information service community is used as a theme: The success of information systems using computers, whether in research or business areas of the corporation, rarely ever depends on the technology. Success finally hinges on the information itself, its quality and ability for humans to communicate real needs which can be translated into a digestible and retrievable form. With the focus clearly on the role as information providers who are concerned with providing information content through various channels, the trends and the challenges are evaluated. Users, who are the reason for building databases, the very enticing visions of how databases can be used, and finally the more specific challenges that database producers must meet in order to remain effective in these future scenarios are all considered. Author

N91-25911# Profile Information, Sunbury-on-Thames (England).
THE ECONOMIC ASPECTS OF DEVELOPING AND MARKETING FULL TEXT DATABASES
Mark Hepworth *In* AGARD, Bridging the Communication Gap Feb. 1991 3 p (For primary document see N91-25902 17-82)
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A brief overview is given of PROFILE Information, the process involved in getting and delivering a full text source of information online and the primarily economic issues involved. The process is broken down into collecting the data, designing and developing the database, delivering and selling the database. Author

N91-25912# Sheffield Univ. (England). Dept. of Information Studies.
BRIDGING THE COMMUNICATION GAP: THE CASE OF THE PORTUGUESE INFORMATION SYSTEM FOR INDUSTRY
Maria Joaquina Barrulas and Zita Correia (Laboratorio Nacional de Engenharia e Tecnologia Industrial, Lisbon, Portugal) *In* AGARD, Bridging the Communication Gap Feb. 1991 15 p (For primary document see N91-25902 17-82)
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The recent Portuguese economic developments are described, as well as the main plans that shape the future developments in Portugal. A brief overview of the industrial structure is provided and the national information infrastructure is analyzed, with special reference to the National Library, the public libraries, the archives, special libraries and information systems, telecommunications, the information industry and available training programs in Library and Information Science. The program for the Development of the Information System for Industry is described and special emphasis is given to the Course for Information Intermediaries, which is aimed at preparing qualified professionals to staff the information units of the System. In order to evaluate the impact of training provided through this Course on job engagement and performance of these information professionals, a survey was conducted and the results obtained are analyzed. The conclusion stressed that, considering the present state of development of the Portuguese information infrastructure, a major contribution to reduce the communication gap is still to invest further in education and training of information professionals. Author

N91-25913# Aerospatiale, Suresnes (France).
POSSIBLE RECOMMENDATIONS TO MINISTRIES AND OTHER AUTHORITIES BASED ON THE FOREGOING PAPERS
Oleg Lavroff *In* AGARD, Bridging the Communication Gap Feb. 1991 9 p (For primary document see N91-25902 17-82)
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Many conclusions are drawn which arise from the other papers presented at the meeting and the tasks are identified which are ahead for information center managers, and recommendations are given that they could make to their superiors or to Government departments with responsibility for information policy, at least in those countries where there is a national information policy. Where there is no such policy, concerted action should be taken to persuade a ministry or other official body to define one, based on the recommendations arising from this meeting. It is of course a very ambitious project, but if all information center managers wish to be able to respond fully to the desires and needs of their end-users (who attach more and more importance to relevance of information and particularly to speedy delivery of it in their own language) the necessary means (logistic, personnel, financial and training), to enable them to exploit fully and effectively the new technologies which will soon be used in research and for information transfer. Author

N91-25914*# Maryland Univ., College Park. Dept. of Electrical Engineering.
THE 1989 NASA-ASEE SUMMER FACULTY FELLOWSHIP PROGRAM IN AERONAUTICS AND RESEARCH Final Report
Harold R. Boroson, Gerald A. Soffen, and Dah-Nien Fan (Howard Univ., Washington, DC.) Sep. 1989 70 p Fellowship program held in Greenbelt, MD, 5 Jun. - 11 Aug. 1989 Prepared in cooperation with NASA. Goddard Space Flight Center, and Howard Univ.
(Grant NGT-21-002-254)
(NASA-CR-188174; NAS 1.26:188174) Avail: NTIS HC/MF A04 CSCL 05B

The 1989 NASA-ASEE Summer Faculty Fellowship Program at the Goddard Space Flight Center was conducted during 5 Jun. 1989 to 11 Aug. 1989. The research projects were previously assigned. Work summaries are presented for the following topics: optical properties data base; particle acceleration; satellite imagery; telemetry workstation; spectroscopy; image processing; stellar spectra; optical radar; robotics; atmospheric composition; semiconductors computer networks; remote sensing; software engineering; solar flares; and glaciers. For individual titles, see N91-25915 through N91-25941.

N91-25915*# State Univ. of New York, Old Westbury. Dept. of Physics and Astronomy.
INFRARED/SUBMILLIMETER OPTICAL PROPERTIES DATA BASE
Phillip W. Alley *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 10-11 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 05B

The general goal was to build a data base containing optical properties, such as reflectance, transmittance, refractive index, in the far infrared to submillimeter wavelength region. This data base would be limited to selected crystalline materials and temperature between 300 and 2 K. The selected materials were: lithium, lead, and strontium; the bromides of potassium and thallium; the carbides of silicone and tungsten; and the materials of KRS5, KRS6, diamond, and sapphire. Last summer, barium fluoride was selected as prototype material for building the data base. This summer the literature search, preparation of the data for barium fluoride was completed. In addition the literature search for data related to the compounds mentioned was completed. The current status is that barium fluoride is in a form suitable for a NASA internal publication. The papers containing the data on the other materials were xeroxed and they are ready to be reduced. On the reverse side, the top figure is a sample combination of data for the index of refraction at 300 K. The lower figure shows the transmittance vs wavelength at 300 and 80 K. These figures are a sample of many which were developed. Since barium fluoride was studied more than most of the materials listed above, it is clear that additional measurements should be made to fill in the gaps present on both temperature and wavelength data. Author

N91-25916*# Keene State Coll., NH. Dept. of Geography.
MASS BALANCE INVESTIGATION OF ALPINE GLACIERS THROUGH LANDSAT TM DATA Abstract Only **c43**
Klaus J. Bayr *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 12 Submitted for publication (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 08B

An analysis of LANDSAT Thematic Mapper (TM) data of the Pasterze Glacier and the Kleines Fleisskees in the Austrian Alps was undertaken and compared with meteorological data of nearby weather stations. Alpine or valley glaciers can be used to study regional and worldwide climate changes. Alpine glaciers respond relatively fast to a warming or cooling trend in temperature through an advance or a retreat of the terminus. In addition, the mass balance of the glacier is being affected. Last year two TM scenes of the Pasterze Glacier of Aug. 1984 and Aug. 1986 were used to study the difference in reflectance. This year, in addition to the scenes from last year, one MSS scene of Aug. 1976 and a TM scene from 1988 were examined for both the Pasterze Glacier and the Kleines Fleisskees. During the overpass of the LANDSAT on 6 Aug. 1988 ground truthing on the Pasterze Glacier was undertaken. The results indicate that there was considerable more reflectance in 1976 and 1984 than in 1986 and 1988. The climatological data of the weather stations Sonnblick and Rudolfshuette were examined and compared with the results found through the LANDSAT data. There were relations between the meteorological and LANDSAT data: the average temperature over the last 100 years showed an increase of .4 C, the snowfall was declining during the same time period but the overall precipitation did not reveal any significant change over the same period. With the use of an interactive image analysis computer, the LANDSAT scenes were studied. The terminus of the Pasterze Glacier retreated 348 m and the terminus of the Kleines Fleisskees 121 m since 1965. This approach using LANDSAT MSS and TM digital data in conjunction with meteorological data can be effectively used to monitor regional and worldwide climate changes. Author

N91-25917*# Southwestern Adventist Coll., Keene, TX. Dept. of Physics.
MONTE CARLO SIMULATION OF PARTICLE ACCELERATION AT ASTROPHYSICAL SHOCKS Abstract Only **c90**
Roy K. Campbell *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 13 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 03B

A Monte Carlo code was developed for the simulation of particle acceleration at astrophysical shocks. The code is implemented in Turbo Pascal on a PC. It is modularized and structured in such a way that modification and maintenance are relatively painless. Monte Carlo simulations of particle acceleration at shocks follow the trajectories of individual particles as they scatter repeatedly across the shock front, gaining energy with each crossing. The particles are assumed to scatter from magnetohydrodynamic (MHD) turbulence on both sides of the shock. A scattering law is used which is related to the assumed form of the turbulence, and the particle and shock parameters. High energy cosmic ray spectra derived from Monte Carlo simulations have observed power law behavior just as the spectra derived from analytic calculations based on a diffusion equation. This high energy behavior is not sensitive to the scattering law used. In contrast with Monte Carlo calculations diffusive calculations rely on the initial injection of supra-thermal particles into the shock environment. Monte Carlo simulations are the only known way to describe the extraction of particles directly from the thermal pool. This was the triumph of the Monte Carlo approach. The question of acceleration efficiency is an important one in the shock acceleration game. The efficiency of shock waves efficient to account for the observed flux of high energy galactic cosmic rays was examined. The efficiency of the acceleration process depends on the thermal particle pick-up and hence the low energy scattering in detail. One of the goals is the self-consistent derivation of the accelerated particle spectra and the MHD turbulence spectra. Presumably the upstream turbulence, which scatters the particles so they can be accelerated, is excited by the streaming accelerated particles and the needed downstream turbulence is convected from the upstream region. The present code is to be modified to include a better description of particle scattering (pitch-angle instead of hard-sphere) and as iterative procedure for treating the self-excitation of the MHD turbulence. Author

N91-25918*# Clemson Univ., SC. Dept. of Electrical and Computer Engineering.

TRANSPORTABLE TELEMETRY WORKSTATION Abstract Only **c17**

Aaron S. Collins *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 14 (For primary document see N91-25914 17-82)

Avail: NTIS HC/MF A04 CSCL 09F

The goal was to complete the design of a prototype for a Transportable Telemetry Workstation (TTW). The Macintosh 2 is used to provide a low-cost system which can house real-time cards mounted on the NuBus inside the Macintosh 2 plus provide a standardized user interface on the Macintosh 2 console. Prior to a telemetry run, the user will be able to configure his real-time telemetry processing functions from the Macintosh 2 console. During a telemetry run, the real-time cards will store the telemetry data directly on a hard disk while permitting viewing of the data cards on the Macintosh 2 console on various selectable formats. The user will view the cards in terms of the functions they perform and the selectable paths through the cards, it is not required to become involved directly in hardware issue except in terms of the functional configuration of the system components. The TTW will accept telemetry data from an RS422 serial input data bus, pass it through a frame synchronizer card and on to a real time controller card via a telemetry backplane bus. The controller card will then route the data to a hard disk through a SCSI interface, and/or to a user interface on the Macintosh 2 console by way of the Macintosh 2 NuBus. The three major components to be designed, therefore, are the TTW Controller Card, the TTW Synchronizer Card, and the NuBus/Macintosh 2 User Interface. Design and prototyping of this state-of-the-art, transportable, low-cost, easy-to-use multiprocessor telemetry system is continuing. Other functions are planned for the future. Author

N91-25919*# Florida State Univ., Tallahassee. Dept. of Oceanography.

CONTINENTAL SHELF FISH PRODUCTION ESTIMATION FROM CZCS CHLOROPHYLL DATA Abstract Only **c48**

Richard L. Iverson *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 15 (For primary document see N91-25914 17-82)

Avail: NTIS HC/MF A04 CSCL 08C

A method for ocean fish production estimation was proposed for development. The method was to use data acquired with the Coastal Zone Color Scanner, and processed into chlorophyll concentrations by the GSFC ocean Sciences Division, in combination with fish production and primary production data acquired from different ocean areas. A linear relation exits between annual fish production and annual phytoplankton carbon production for a wide range of coastal ocean environments. The uses of several existing algorithms which relate primary production to CZCS chlorophyll data as input to the fish production regression model is proposed. A question relating phytoplankton production to CZCS chlorophyll was obtained by Eppley (1984) using chlorophyll data obtained from field samples, equivalent to chlorophyll data obtained from CZCS imagery, and primary production data obtained from ship-board observations on a wide variety of coastal and open ocean environments. This equation was modified with additional data and was successfully tested using CZCS data and field chlorophyll and phytoplankton production data obtained from northeastern North American continental shelf waters and Atlantic open ocean waters. The modified Eppley (1984) relation also estimated phytoplankton annual carbon production in the Sargasso Sea within the confidence limits of a mean value obtained from the Eppley (1984) equation for oceanic waters that provide about 90 percent of total ocean primary production. The modified Eppley production formula applied to CZCS chlorophyll data obtained from several northeastern North American coastal environments gave phytoplankton annual carbon production values similar to the values used in the fish production regression equation. Author

N91-25920*# Charles County Community Coll., La Plata, MD. Dept. of Biology and Physical Science.

LOW TEMPERATURE MEASUREMENT OF THE VAPOR PRESSURES OF PLANETARY MOLECULES Abstract Only **c91**

George F. Kraus *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 16-17 (For primary document see N91-25914 17-82)

Avail: NTIS HC/MF A04 CSCL 03B

Interpretation of planetary observations and proper modeling of planetary atmospheres are critically upon accurate laboratory data for the chemical and physical properties of the constitutes of the atmospheres. It is important that these data are taken over the appropriate range of parameters such as temperature, pressure, and composition. Availability of accurate, laboratory data for vapor pressures and equilibrium constants of condensed species at low temperatures is essential for photochemical and cloud models of the atmospheres of the outer planets. In the absence of such data, modelers have no choice but to assume values based on an educated guess. In those cases where higher temperature data are available, a standard procedure is to extrapolate these points to the lower temperatures using the Clausius-Clapeyron equation. Last summer the vapor pressures of acetylene (C2H2) hydrogen cyanide (HCN), and cyanoacetylene (HC3N) was measured using two different methods. At the higher temperatures 1 torr and 10 torr capacitance manometers were used. To measure very low pressures, a technique was used which is based on the infrared absorption of thin film (TFIR). This summer the vapor pressure of acetylene was measured the TFIR method. The vapor pressure of hydrogen sulfide (H2S) was measured using capacitance manometers. Results for H2O agree with literature data over the common range of temperature. At the lower temperatures the data lie slightly below the values predicted by extrapolation of the Clausius-Clapeyron equation. Thin film infrared (TFIR) data for

acetylene lie significantly below the values predicted by extrapolation. It is hoped to bridge the gap between the low end of the CM data and the upper end of the TFIR data in the future using a new spinning rotor gauge. Author

N91-25921*# Puerto Rico Univ., San Juan. Terrestrial Ecology Div.

ECOLOGICAL APPLICATIONS OF HIGH RESOLUTION SPECTROMETRY Abstract Only c45

William T. Lawrence *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 18 (For primary document see N91-25914 17-82)

Avail: NTIS HC/MF A04 CSCL 13B

Future directions of NASA's space program plans include a significant effort at studying the Earth as a system of interrelated ecosystems. As part of NASA's Earth Observing System (Eos) Program a series of space platforms will be launched and operated to study the Earth with a variety of active and passive instruments. Several of the Eos instruments will be capable of imaging the planet's surface reflectance on a large number of very narrow portions of the solar spectrum. After the development of appropriate algorithms, this reflectance information will be used to determine key parameters about the structure and function of terrestrial and aquatic ecosystems and the pattern and processes of those systems across large areas of the globe. Algorithm development applicable to terrestrial systems will permit the inference of ecological processes from high resolution spectrometry data, similar to that to be forthcoming from the Eos mission. The first summer was spent working with tropical soils and relating their reflectance characteristics to particle size, iron content, and color. This summer the emphasis is on vegetation and work was begun with the Forest Ecosystems Dynamics Project in the Earth Resources Branch where both optical and radar characteristics of a mixed conifer/hardwood forest in Maine are being studied for use in a ecological modeling effort. A major series of aircraft overflights will take place throughout the summer. Laboratory and field spectrometers are used to measure the spectral reflectance of a hierarchy of vegetation from individual leaves to whole canopies for eventual modeling of their nutrient content using reflectance data. Key leaf/canopy parameters are being approximated including chlorophyll, nitrogen, phosphorus, water content, and leaf specific weight using high resolution spectrometry alone. Measurements are made of carbon exchange across the landscape for input to a spatial modeling effort to gauge production within the forest. A Geographic Information System approach is used to associate these data, images, and other collateral information for the forest into a database with a common projection suitable for spatial modeling. Author

N91-25922*# Salisbury State Univ., MD. Dept. of Mathematical Sciences.

LAND ALTIMETRY USING SATELLITE DATA FROM THE GEOSAT SEA ALTIMETER Abstract Only c43

Philip E. Luft *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 19 (For primary document see N91-25914 17-82)

Avail: NTIS HC/MF A04 CSCL 08B

Several techniques are proposed or assessed from the GEOSAT sea altimeter, and changes are recommended in future RADAR altimeters. The first technique tried was to cross-correlate each waveform with the preceding one. Then the position giving the maximum correlation was taken as the correct placement of the new waveform in its data window. The resulting altitude profile was slightly more variable than that of the c[illegible]-board tracker over flat rock (Salar de Uyuni), so apparently successive waveforms are too dissimilar to correlate. When cross-correlation failed, compensation was made for averaging. Raw waveforms are averaged in groups of 100 and it is these average waveforms which are available for ground processing. But while the 100 are being received, the window position is moved in time, at different constant rates for the first 50 and last 50. Assuming an unchanging waveform and a single window rate for the 100, first and last waveforms were obtained. Averaging their half-height arrival times gave an altitude profile similar to the median and centroid methods. The variability of this altitude profile suggests that even raw waveforms in a group of 100 may be too dissimilar to correlate. In other techniques, the pulse was judged to have arrived when one of these criteria was met: the wave amplitude meets a certain absolute threshold; wave amplitude meets a certain relative threshold; certain fraction of the area of the waveform has passed; and centroid of the waveform has passed. All methods gave altitude profiles at least as variable as the on-board tracker, and all were biased at least 0.5 meter to low altitudes, except the threshold detector. The threshold detector can be filtered spatially to resemble the on-board tracker, and perhaps it could be implemented without feedback. For operating over land, these changes are recommended in future altimeters: The window should not move while raw waveforms are being averaged; some of the raw waveforms should be telemetered to earth for study, placing the waveform in the window should allow for shape variety; and some form of threshold detector might be used to find the signal and place it. Author

N91-25923*# Morgan State Univ., Baltimore, MD. Dept. of Electrical Engineering.

IMAGE DATA COMPRESSION INVESTIGATION Abstract Only c61

Carlos Myrie *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 20 (For primary document see N91-25914 17-82)

Avail: NTIS HC/MF A04 CSCL 09B

NASA continuous communications systems growth has increased the demand for image transmission and storage. Research and analysis was conducted on various lossy and lossless advanced data compression techniques or approaches used to improve the efficiency of transmission and storage of high volume stellite image data such as pulse code modulation (PCM), differential PCM (DPCM), transform coding, hybrid coding, interframe coding, and adaptive technique. In this presentation, the fundamentals of image data compression utilizing two techniques which are pulse code modulation (PCM) and differential PCM (DPCM) are presented along with an application utilizing these two coding techniques. Author

N91-25924*# State Univ. of New York, Oswego. Dept. of Earth Sciences.

NITROGEN ABUNDANCES FROM UV LINES OF HgMn AND STANDARD LATE-B STARS c89

Scott W. Roby *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 21-22 (For primary document see N91-25914 17-82)

Avail: NTIS HC/MF A04 CSCL 03A

A recent survey by Roby (1987) discovered that the relatively weak high excitation lines of N 1 near 7468 and 8680 A were undetectable in the majority of HgMn stars, leading to upper limits on the N abundance of roughly ten times below that of the solar N abundance. Standard stars with similar temperatures (10,000 to 13,000 K) did exhibit these same N lines and were found to have roughly solar N abundances. The N abundances were redetermined in two HgMn stars and four standard stars using the strong, low excitation lines of N 1 found in the ultraviolet. The observational data consisted of high quality, high resolution, co-added International Ultraviolet Explorer spectra which was previously collected and reduced. Examination of the spectra plus considerations of signal/noise and severe line blending led to the choice of three promising N 1 lines located at 1742.7, 1745.3 and 1411.9 A. The atomic data for these lines were previously calculated using the best laboratory measurements found in a search of the relevant literature. The chosen N lines turned out to be blended significantly with Fe 2 lines. To obtain the abundances for N synthetic spectra were computed to match the observed spectra. The synthetic spectra were calculated using lie-blanketed model atmospheres, stellar parameters, and abundances for the other elements based upon previous work by S. Adelman. The N abundance was then adjusted to give the best fit of the observed

line profiles. In the 2 HgMn stars, the N lines were again found to be undetectable, but the stronger intrinsic strength of the new lines yield more stringent upper limits than those obtained previously. Model atmosphere and abundances were updated in two stars where new results were reported. An additional N 1 line and an additional standard star were added to the program. A line opacity model was developed for a missing feature adjacent to the N 1 line at 1745.2 A, leading to a 25 percent improvement in the determined from this line. Author

N91-25925*# Murray State Univ., KY. Dept. of Physics.
SPECTRAL CALIBRATION ANALYSIS OF THE AIRBORNE OCEANOGRAPHIC LIDAR Abstract Only c48
Carlton E. Rousey *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 23 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 08C

Efforts were concentrated on the spectral resolution of the Airborne Oceanographic Lidar (AOL). This year's work was targeted towards the analysis of calibration techniques to enable the AOL to measure absolute radiances of both passive and active modes of operation. Absolute spectral calibration of the AOL is necessary in order to fully understand and monitor the sensitivity and stability of the total system. Calibration is also needed to obtain valid surface truth data, with which to improve the accuracy of satellite-borne oceanic color scanners. In particular, accurate measurements of oceanic chlorophyll concentrations rests upon reliable irradiance calibrations of both laser induced and solar induced chlorophyll fluoresence. An analysis was performed on the spectral calibration methods used by the AOL. The optical path of the instrumentation was examined to study how the radiance from a calibration sphere was influenced. Ray tracing analysis was performed, including the Cassegrain-telescope optics. It was determined that the calibration radiance was significantly effected by optical-defocusing, due to close positioning of the calibration sphere with respect to the telescope. Since the multi-mode usages of the AOL require varying altitudes and trajectories, a computational algorithm was developed to compensate for image distortions of the telescope optics. Secondary mirror blockage, secondary vignetting, and beam divergence was determined, in order to account for the actual amount of calibrated flux received at the spectral sensors. Author

N91-25926*# Buena Vista Coll., Storm Lake, IA. School of Natural Sciences.
THE ROLE OF POLAR STRATOSPHERIC CLOUDS ON TOTAL OZONE MINIHOLE EVENTS Abstract Only c45
Joseph L. Sabutis *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 24 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 13B

Using seven years of data from tha SAM 2 (Stratospheric Aerosol Measurement 2) and TOMS (Total Ozone Mapping Spectrometer) instruments, along with 70 mbar temperatures extracted from an NMC analysis, the effect of the austral spring polar stratospheric clouds (PSC) on the formation of total ozone miniholes is investigated. A total ozone minihole event is designated as the rapid decrease of more than 20 DU of total ozone over a time period of a day and a spatial extent of approximately 1000 by 1000 km. The severe decrease of total ozone during these minihole events could be explained in part by PSC being formed at altitudes of 10 to 24 km and preventing scattered UV radiation from ozone below the cloud from reaching the TOMS instrument. A result of the cloud's opaqueness is that the total ozone retrieval from TOMS data would underestimate the ozone column in the vicinity of the PSC. The approach to investigate the effect of PSC on total ozone was to use SAM 2 aerosol extinction values in conjunction with NMC stratospheric temperatures to determine if PSC are present during total ozone minihole events occurring during August and September, 1979 to 1986. The minihole events during these seven years were divided into two types: type 1, where the minihole region of 24 hour darkness from regions exposed to sunlight, and type 2, where the minihole occurred 5 to 10 degrees north of the terminator. The presence of PSC in a given region was ascertained by a maximum aerosol extinction greater than .006/km occurring with a temperature less than 189 K. It is found that PSC are consistently present with type 2 minihole events. This is contrasted with PSC rarely occurring in the same vicinity of type 2 miniholes. Also observed of that type 1 minihole events have minimum total ozone values which are on the average 3 to 10 DU smaller than type 2 miniholes. It can be concluded that care must be taken when trying to deduce a dynamical explanation of minihole events near the polar terminator and the role of PSC must be accounted for in type 1 minihole formation. Author

N91-25927*# Clark-Atlanta Univ., GA. Dept. of Mathematical and Computer Sciences.
CHOICE OF GAUGE IN 2-PHOTON 1s-2s TRANSITION IN ATOMIC HYDROGEN AND PSEUDOSTATE EXPANSIONS c72
Abdulalim A. Shabazz *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 25 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 20H

The problem of gauge choice in multiphoton transitions in connection with the proper choice of the unperturbed wave functions require to insure gauge invariance was considered. J. Bassani, J. J. Forney, and A. Quattropani considered the case of 2-photon 1s-2s transition rate for hydrogen, using gauges vector E x vector r and vector A x vector p. Exactly the same results were obtained for the two gauges, but the findings indicate that the vector E x vector r interaction tends to the final result with a small number of intermediate states and is therefore the one to be used in any approximate calculation. Whether the so-called pseudostate expansion method works equally well with either gauge was tested. To accomplish this task, in addition to researching the problem, the FORTRAN programming was learned and a FORTRAN program was constructed for the calculation of the dimensionless 2-photon transition probability amplitude D(v) for 1s-2s transition in Hydrogen as a function as a function of the incident photon frequency v in gauge vector E x vector p at certain values of v, using the pseudostate method. However, some puzzling unresolved difficulties were experienced in the calculation. Then should the pseudostate calculations prove successful for gauge vector E x vector r the method will be applied to gauge vector A x vector p. If successful, then the problem is complete. Author

N91-25928*# Gallaudet Coll., Washington, DC. Dept. of Physics.
MINIMUM LENGTH Pb/SCIN DETECTOR FOR EFFICIENT COSMIC RAY IDENTIFICATION Abstract Only c93
H. David Snyder *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 26 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 03B

A study was made of the performance of a minimal length cosmic ray shower detector that would be light enough for space flight and would provide efficient identification of positions and protons. Cosmic ray positions are mainly produced in the decay chain of: Pion yields Muon yields Positron and they provide a measure of the matter density traversed by primary protons. Present positron flux measurements are consistent with the Leaky Box and Halo models for sources of cosmic rays. Abundant protons in the space environment are a significant source of background that would wash out the positron signal. Protons and positrons produced very distictive showers of particles when they enter matter; many studies have been published on their behavior on large calorimeter detectors. The challenge is to determine the minimal material necessary (minimal calorimeter depth) for positive particles identification. The primary instrument for the investigation is the Monte Carlo code GEANT, a library of programs from CERN that can be used to model experimental geometry, detector responses and particle interaction processes. The use of the Monte

Carlo approach is crucial since statistical fluctuations in shower shape are significant. Studies conducted during the 1988 summer program showed that straightforward approaches to the problem achieved 85 to 90 percent correct identification, but left a residue of 10 to 15 percent misidentified particles. This percentage improved to a few percent when multiple shower-cut criteria were applied to the data. This summer, the same study was extended to employ several physical and statistical methods of identifying response of the calorimeter and the efficiency of the optimal shower cuts to off-normal incidence particle was determined. Author

N91-25929*# West Virginia State Coll., Charleston. Dept. of Industrial Technology.
LOW FREQUENCY ELECTRIC AND MAGNETIC FIELDS Abstract Only **c46**
Craig Spaniol *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 27 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 08G

Following preliminary investigations of the low frequency electric and magnetic fields that may exists in the Earth-ionospheric cavity, measurements were taken with state-of-the art spectrum analyzers. As a follow up to this activity, an investigation was initiated to determine sources and values for possible low frequency signal that would appear in the cavity. The lowest cavity resonance is estimated at about 8 Hz, but lower frequencies may be an important component of our electromagnetic environment. The potential field frequencies produced by the electron were investigated by a classical model that included possible cross coupling of the electric and gravitation fields. During this work, an interesting relationship was found that related the high frequency charge field with the extremely low frequency of the gravitation field. The results of numerical calculations were surprisingly accurate and this area of investigation is continuing. The work toward continued development of a standardized monitoring facility is continuing with the potential of installing the prototype at West Virginia State College early in 1990. This installation would be capable of real time monitoring of ELF signals in the Earth-ionoshpere cavity and would provide some directional information. A high gain, low noise, 1/f frequency corrected preamplifier was designed and tested for the ferrite core magnetic sensor. The potential application of a super conducting sensor for the ELF magnetic field detection is under investigation. It is hoped that a fully operational monitoring network could pinpoint the location of ELF signal sources and provide new information on where these signals originate and what causes them, assuming that they are natural in origin. Author

N91-25930*# George Washington Univ., Washington, DC. Dept. of Electrical Engineering and Computer Science.
DIGITAL REDESIGN OF THE CONTROL SYSTEM FOR THE ROBOTICS RESEARCH CORPORATION MODEL K-1607 ROBOT Abstract Only **c37**
Robert L. Carroll *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 28 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 13I

The analog control system for positioning each link of the Robotics Research Corporation Model K-1607 robot manipulator was redesigned for computer control. In order to accomplish the redesign, a linearized model of the dynamic behavior of the robot was developed. The parameters of the model were determined by examination of the input-output data collected in closed-loop operation of the analog control system. The robot manipulator possesses seven degrees of freedom in its motion. The analog control system installed by the manufacturer of the robot attempts to control the positioning of each link without feedback from other links. Constraints on the design of a digital control system include: the robot cannot be disassembled for measurement of parameters; the digital control system must not include filtering operations if possible, because of lack of computer capability; and criteria of goodness of control system performing is lacking. The resulting design employs sampled-data position and velocity feedback. The criteria of the design permits the control system gain margin and phase margin, measured at the same frequencies, to be the same as that provided by the analog control system. Author

N91-25931*# Florida Univ., Gainesville. Dept. of Astronomy.
ATMOSPHERIC OCCULTATION OF A SOLAR FLARE IN HARD X RAYS Abstract Only **c92**
Kwan-Yu Chen *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 29 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 03B

The objective of this study is two-fold: to investigate the absorption of hard x rays along a tangential path through the terrestrial atmosphere, and to locate, other than the use of imaging devices, the flare source of x ray emission in the sun. Observational data were taken with the Hard X Ray Burst Spectrometer (HXRBS) on board the Solar Maximum Mission satellite (SMM). The occultation event chosen for investigation is the flare on 14 October 1981. Night fell on SMM during the decaying phase of the flare. In about fifteen seconds, the x ray flux decreased to zero. The model for computing synthetic light curve, which is directly comparable to the observed curve, consists of two computing programs. One is a modified version of an existing code, which compute the coordinates of the tangent points of the SMM-sun lines. The other program computed the atmospheric densities along the angles (N to S and E to W) measured from the center of the sun. The various model also depends on the destination of the terrestrial atmosphere at geocentric positions of SMM and the sun, the mean atmospheric densities at different heights and latitudes, and the x ray absorption cross of nitrogen, oxygen, and argon. The optical length, at a given time and for a x ray energy, is computed with the two angular parameters. The fit of a particular synthetic light, curve, i.e., the exponentials of the optical lengths, to the observed eclipse curve, yields the desired angular parameters. Author

N91-25932*# District of Columbia Univ., Washington, DC. Dept. of Mechanical Engineering.
THE TRANSIENT PERFORMANCE OF A TWO-PHASE FLUID RESERVOIR Abstract Only **c34**
Joseph Chi *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 30 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 20D

Thermal control of future large, high power spacecraft will require a two-phase fluid central bus. The two-phase fluid reservoir is a critical component in the two-phase fluid bus. It both controls the saturation temperature and provides a space for volumetric changes. A dynamic reservoir simulation model does not currently exist, but it is needed to expedite efforts and reduce risk. During 1989 an effort was made to develop a simulation model of the transient performance of a two-phase fluid reservoir. As a beginning, a preliminary model was developed. It is based upon component mathematical models in lumped parametric form and build upon five component mathematical models for calculating dynamic responses of two-phase fluid reservoirs, primary feedback elements, controller commands, heater actuators, and reservoir heaters. As much as possible, the model took advantage of the available SINDA'85/FLUINT thermal/fluid integrator. Additional calculation logic and computer subroutines were developed to complete implementation of the model. The model is capable of simulating dynamic response of an equilibrium two-phase fluid reservoir. Modification of the model to include the liquid/vapor nonequilibrium is required for applications of the model to simulate performance of reservoir in which the liquid and vapor phases of the reservoir fluid are not in equilibrium. In addition, the model in its present form, needs to be refined in several respects. More empirical data are needed to guide the model development. The model may then be used to conduct a full parametric study of two-phase fluid reservoirs. More complexities in two-phaes flow regions in laboratory and flight conditions may have to be considered eventually if empirical data cannot be simulated

satisfactorily. System with other components arrangement also need to be simulated if optimization is ever to be attained. The present model does, however, preliminarily demonstrates that such analyses are quite possible and offers a far less expensive method to understand the transient of a two-phase fluid reservoir system than a totally headware approach. Author

N91-25933*# George Mason Univ., Fairfax, VA. Dept. of Electrical and Computer Engineering.

GALLIUM ARSENIDE PROCESSING FOR GATE ARRAY LOGIC Abstract Only **c76**

Eric D. Cole *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 31 (For primary document see N91-25914 17-82)

Avail: NTIS HC/MF A04 CSCL 20L

The development of a reliable and reproducible GaAs process was initiated for applications in gate array logic. Gallium Arsenide is an extremely important material for high speed electronic applications in both digital and analog circuits since its electron mobility is 3 to 5 times that of silicon, this allows for faster switching times for devices fabricated with it. Unfortunately GaAs is an extremely difficult material to process with respect to silicon and since it includes the arsenic component GaAs can be quite dangerous (toxic) especially during some heating steps. The first stage of the research was directed at developing a simple process to produce GaAs MESFETs. The MESFET (MEtal Semiconductor Field Effect Transistor) is the most useful, practical and simple active device which can be fabricated in GaAs. It utilizes an ohmic source and drain contact separated by a Schottky gate. The gate width is typically a few microns. Several process steps were required to produce a good working device including ion implantation, photolithography, thermal annealing, and metal deposition. A process was designed to reduce the total number of steps to a minimum so as to reduce possible errors. The first run produced no good devices. The problem occurred during an aluminum etch step while defining the gate contacts. It was found that the chemical etchant attacked the GaAs causing trenching and subsequent severing of the active gate region from the rest of the device. Thus all devices appeared as open circuits. This problem is being corrected and since it was the last step in the process correction should be successful. The second planned stage involves the circuit assembly of the discrete MESFETs into logic gates for test and analysis. Finally the third stage is to incorporate the designed process with the tested circuit in a layout that would produce the gate array as a GaAs integrated circuit. Author

N91-25934*# Towson State Univ., MD. Dept. of Computer and Information Sciences.

COMPUTER NETWORK ENVIRONMENT PLANNING AND ANALYSIS Abstract Only **c62**

John F. Dalphin *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 32 (For primary document see N91-25914 17-82)

Avail: NTIS HC/MF A04 CSCL 09B

The GSFC Computer Network Environment provides a broadband RF cable between campus buildings and ethernet spines in buildings for the interlinking of Local Area Networks (LANs). This system provides terminal and computer linkage among host and user systems thereby providing E-mail services, file exchange capability, and certain distributed computing opportunities. The Environment is designed to be transparent and supports multiple protocols. Networking at Goddard has a short history and has been under coordinated control of a Network Steering Committee for slightly more than two years; network growth has been rapid with more than 1500 nodes currently addressed and greater expansion expected. A new RF cable system with a different topology is being installed during summer 1989; consideration of a fiber optics system for the future will begin soon. Summmer study was directed toward Network Steering Committee operation and planning plus consideration of Center Network Environment analysis and modeling. Biweekly Steering Committee meetings were attended to learn the background of the network and the concerns of those managing it. Suggestions for historical data gathering have been made to support future planning and modeling. Data Systems Dynamic Simulator, a simulation package developed at NASA and maintained at GSFC was studied as a possible modeling tool for the network environment. A modeling concept based on a hierarchical model was hypothesized for further development. Such a model would allow input of newly updated parameters and would provide an estimation of the behavior of the network. Author

N91-25935*# Johns Hopkins Univ., Shadyside, MD.

THE USE OF AIRCRAFT AND SATELLITE REMOTE SENSING OF PHYTOPLANKTON CHLOROPHYLL CONCENTRATIONS IN CASE 2 ESTUARINE WATERS OF THE CHESAPEAKE BAY Abstract Only **c43**

Lawrence W. Harding, Jr. *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 33 (For primary document see N91-25914 17-82)

Avail: NTIS HC/MF A04 CSCL 08C

Two projects using remote sensing of phytoplankton chlorophyll concentrations in the Chesapeake Bay estuary were proposed. The first project used aircraft remote sensing with a compact radiometer system developed at NASA's Goddard Space Flight Center (GSFC), the Ocean Data Acquisition System (ODAS). ODAS includes three radiometers at 460, 490, and 520 nm, an infrared temperature sensor (PRT-5), Loran-C for navigation, and a data acquisition system using a PC and mass storage device. This instrument package can be flown in light aircraft at relatively low expense, permitting regular and frequent flights. Sixteen flights with ODAS were completed using the Virginia Institute of Marine Science's De Havilland 'Beaver'. The goal was to increase spatial and temporal resolution in assaying phytoplankton pigment concentrations in the Chesapeake. At present, analysis is underway of flight data collected between March and July 1989. The second project focused on satellite data gathered with the Nimbus-7 Coastal Zone Color Scanner (CZSC) between late 1978 and mid 1986. The problem in using CZSC data for the Chesapeake Bay is that the optical characteristics of this (and many) coastal and estuarine waters are distinct from those of the open ocean for which algorithms for computing pigment concentrations were developed. The successful use of CZCS data for the estuary requires development of site-specific algorithms and analytical approaches. Of principal importance in developing site-specific procedures is the availability of in-situ data on pigment concentrations. A significant data set was acquired from EPA's Chesapeake Bay Program in Annapolis, Maryland, and clear satellite scenes are being analyzed for which same-day sea truth measurements of pigment were obtained. Both the University of Miami and GSFC Seapak systems are being used in this effort. The main finding to date is an expected one, i.e., the algorithms developed for oceanic waters are inadequate to compute pigment concentrations for the Case 2 waters of the Chesapeake Bay. One reason is the overestimation of aerosol radiances by assuming that water-leaving radiance in Band 4 of CZCS (670 nm) is zero, an assumption that is invalid for the Bay. This prompted any attempts to iterative procedures for estimating the proportion of the Band 4 radiance that is actually attributable to aerosol by estimating the water-leaving component using optical data. A cruise on the Chesapeake the week of 7 August 1989 was conducted to collect additional optical data necessary to this task. Author

N91-25936*# Morgan State Univ., Baltimore, MD. Dept. of Industrial Engineering.

DEVELOPMENT OF A FUNDING, COST, AND SPENDING MODEL FOR SATELLITE PROJECTS **c83**

Jesse P. Johnson *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 34 (For primary document see N91-25914 17-82)

Avail: NTIS HC/MF A04 CSCL 05C

The need for a predictive budget/funging model is obvious. The current models used by the Resource Analysis Office (RAO)

are used to predict the total costs of satellite projects. An effort to extend the modeling capabilities from total budget analysis to total budget and budget outlays over time analysis was conducted. A statistical based and data driven methodology was used to derive and develop the model. Th budget data for the last 18 GSFC-sponsored satellite projects were analyzed and used to build a funding model which would describe the historical spending patterns. This raw data consisted of dollars spent in that specific year and their 1989 dollar equivalent. This data was converted to the standard format used by the RAO group and placed in a database. A simple statistical analysis was performed to calculate the gross statistics associated with project length and project cost ant the conditional statistics on project length and project cost. The modeling approach used is derived form the theory of embedded statistics which states that properly analyzed data will produce the underlying generating function. The process of funding large scale projects over extended periods of time is described by Life Cycle Cost Models (LCCM). The data was analyzed to find a model in the generic form of a LCCM. The model developed is based on a Weibull function whose parameters are found by both nonlinear optimization and nonlinear regression. In order to use this model it is necessary to transform the problem from a dollar/time space to a percentage of total budget/time space. This transformation is equivalent to moving to a probability space. By using the basic rules of probability, the validity of both the optimization and the regression steps are insured. This statistically significant model is then integrated and inverted. The resulting output represents a project schedule which relates the amount of money spent to the percentage of project completion. Author

N91-25937*# Kansas Coll. of Technology, Salina. Dept. of Computer Science.

DETECTION AND AVOIDANCE OF ERRORS IN COMPUTER SOFTWARE c61

Les Kinsler *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 35 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 09B

The acceptance test errors of a computer software project to determine if the errors could be detected or avoided in earlier phases of development. GROAGSS (Gamma Ray Observatory Attitude Ground Support System) was selected as the software project to be examined. The development of the software followed the standard Flight Dynamics Software Development methods. GROAGSS was developed between August 1985 and April 1989. The project is approximately 250,000 lines of code of which approximately 43,000 lines are reused from previous projects. GROAGSS had a total of 1715 Change Report Forms (CRFs) submitted during the entire development and testing. These changes contained 936 errors. Of these 936 errors, 374 were found during the acceptance testing. These acceptance test errors were first categorized into methods of avoidance including: more clearly written requirements; detail review; code reading; structural unit testing; and functional system integration testing. The errors were later broken down in terms of effort to detect and correct, class of error, and probability that the prescribed detection method would be successful. These determinations were based on Software Engineering Laboratory (SEL) documents and interviews with the project programmers. A summary of the results of the categorizations is presented. The number of programming errors at the beginning of acceptance testing can be significantly reduced. The results of the existing development methodology are examined for ways of improvements. A basis is provided for the definition is a new development/testing paradigm. Monitoring of the new scheme will objectively determine its effectiveness on avoiding and detecting errors. Author

N91-25938*# Dillard Univ., New Orleans, LA. Urban Studies and Public Policy Inst.

SPECIFICATION OF PARAMETERS FOR DEVELOPMENT OF A SPATIAL DATABASE FOR DROUGHT MONITORING AND FAMINE EARLY WARNING IN THE AFRICAN SAHEL Abstract Only

Gilbert L. Rochon *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 36 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 05B

Parameters were described for spatial database to facilitate drought monitoring and famine early warning in the African Sahel. The proposed system, referred to as the African Drought and Famine Information System (ADFIS) is ultimately recommended for implementation with the NASA/FEMA Spatial Analysis and Modeling System (SAMS), a GIS/Dymanic Modeling software package, currently under development. SAMS is derived from FEMA'S Integration Emergency Management Information System (IEMIS) and the Pacific Northwest Laborotory's/Engineering Topographic Laboratory's Airland Battlefield Environment (ALBE) GIS. SAMS is primarily intended for disaster planning and resource management applications with the developing countries. Sources of data for the system would include the Developing Economics Branch of the U.S. Dept. of Agriculture, the World Bank, Tulane University School of Public Health and Tropical Medicine's Famine Early Warning Systems (FEWS) Project, the USAID's Foreign Disaster Assistance Section, the World Resources Institute, the World Meterological Institute, the USGS, the UNFAO, UNICEF, and the United Nations Disaster Relief Organization (UNDRO). Satellite imagery would include decadal AVHRR imagery and Normalized Difference Vegetation Index (NDVI) values from 1981 to the present for the African continent and selected Landsat scenes for the Sudan pilot study. The system is initially conceived for the MicroVAX 2/GPX, running VMS. To facilitate comparative analysis, a global time-series database (1950 to 1987) is included for a basic set of 125 socio-economic variables per country per year. A more detailed database for the Sahelian countries includes soil type, water resources, agricultural production, agricultural import and export, food aid, and consumption. A pilot dataset for the Sudan with over 2,500 variables from the World Bank's ANDREX system, also includes epidemiological data on incidence of kwashiorkor, marasmus, other nutritional deficiencies, and synergistically-related infectious diseases. Author

N91-25939*# Dillard Univ., New Orleans, LA. Urban Studies and Public Policy Inst.

INTEGRATING NASA'S LAND ANALYSIS SYSTEM (LAS) IMAGE PROCESSING SOFTWARE WITH AN APPROPRIATE GEOGRAPHIC INFORMATION SYSTEM (GIS): A REVIEW OF CANDIDATES IN THE PUBLIC DOMAIN Abstract Only c43

Gilbert L. Rochon *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 37 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 08B

A user requirements analysis (URA) was undertaken to determine and appropriate public domain Geographic Information System (GIS) software package for potential integration with NASA's LAS (Land Analysis System) 5.0 image processing system. The necessity for a public domain system was underscored due to the perceived need for source code access and flexibility in tailoring the GIS system to the needs of a heterogenous group of end-users, and to specific constraints imposed by LAS and its user interface, Transportable Applications Executive (TAE). Subsequently, a review was conducted of a variety of public domain GIS candidates, including GRASS 3.0, MOSS, IEMIS, and two university-based packages, IDRISI and KBGIS. The review method was a modified version of the GIS evaluation process, development by the Federal Interagency Coordinating Committee on Digital Cartography. One IEMIS-derivative product, the ALBE (AirLand Battlefield Environment) GIS, emerged as the most promising candidate for integration with LAS. IEMIS (Integrated Emergency Management Information System) was developed by the Federal Emergency Management Agency (FEMA). ALBE GIS is currently under development at the Pacific Northwest Laboratory under contract with the U.S. Army Corps of Engineers' Engineering Topographic Laboratory (ETL). Accordingly, recommendations are offered with respect to a potential LAS/ALBE GIS linkage and

with respect to further system enhancements, including coordination with the development of the Spatial Analysis and Modeling System (SAMS) GIS in Goddard's IDM (Intelligent Data Management) develcpments in Goddard's National Space Science Data Center. Author

N91-25940*# Alfred Univ., NY. Dept. of Physics.
SOLAR FLARE HARD AND SOFT X RAY RELATIONSHIP DETERMINED FROM SMM HXRBS AND BCS DATA Abstract Only c92
G. David Toot *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 38 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 03B

The exact nature of the solar flare process is still somewhat a mystery. A key element to understanding flares if the relationship between the hard x rays emitted by the most energetic portions of the flare and the soft x rays from other areas and times. This relationship was studied by comparing hard x ray light curved from the Hard X-Ray Burst Spectrometer (HXRBS) with the soft x ray light curve and its derivation from the Bent Crystal Spectrometer (BCS) which is part of the X-Ray Polychrometer (XRP), these instruments being on the Solar Maximum Mission spacecraft (SMM). Data sample was taken from flares observed with the above instruments during 1980, the peak of the previous maximum of solar activity. Flares were chosen based on complete coverage of the event by several instruments. The HXRBS data covers the x ray spectrum from about 25 keV to about 440 keV in 15 spectral channels, while the BCS data used covers a region of the Spectrum around 3 angstroms including emission from the Ca XIX ion. Both sets of data were summed over their spectral ranges and plotted against time at a maximum time resolution of around 3 seconds. The most popular theory of flares holds that a beam of electrons produces the hard x rays by bremsstrahlung while the soft x rays are the thermal response to this energy deposition. The question is whether the rate of change of soft x ray emission might reflect the variability of the electron beam and hence the variability of the hard x rays. To address this, we took the time derivative of the soft x ray light curve and compared it to the hard flares, 12 of them showed very closed agreement between the soft x ray derivative and the hard x ray light curve. The other five did not show this behavior but were similar to each other in general soft x ray behavior. Efforts to determine basic differences between the two kinds of flares continue. In addition the behavior of soft x ray temperature of flares was examined. Author

N91-25941*# Bowie State Univ., MD. Dept. of Computer Science.
DATA SYSTEM INTERPROBABILITY Abstract Only c62
Nagi T. Wakim *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 39 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 09B

Software was developed and tested which allows an end-user to build a book data object in an interactive fashion. The electronic book model was developed for the Library front-end of the DAVID (Distributed Access View Integrated Database) system. It is a complex data object which is capable of holding data of different types and formats. After the task, the plan was to assess the Book model and investigate the possibility of it serving as a knowledge base for a expert system front-end to the DAVID system. For the rest of the fellowship period, data system interoperability was examined. Specifically, a plan was prepared titled Implementations of the Land Analysis System (LAS) to Meet UNEP/GRID Requirements. This plan is aimed at reaching the goal of building one virtual global change information system which will link existing and future data systems allowing earth and space scientists to learn about, locate, access, and correlate data of interest regardless of its physical location. The plan proposed the construction of a master directory (MD) for the European data systems that is equivalent in structure to NASA's MD. The MD is to contain brief, high-level information about existing Earth and space science data sets sufficient for a user to know where data of interest reside and how to go about getting additional information. The plan also outlined the tasks that would be involved to electronically connect the MD system to the various discipline data systems (e.g., LAS) in order to achieve general interroperabilty, that is, the abilty to perform cross-systems searches and exchange of and access to distributed information. Author

N91-25942# National Inst. of Standards and Technology, Gaithersburg, MD. Information Resources and Services Div.
ABSTRACT AND INDEX COLLECTION IN THE RESEARCH INFORMATION CENTER OF THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (4TH ED.) Final Report
D. Cunningham Dec. 1990 36 p
(PB91-148494; NIST/SP-803) Avail: NTIS HC/MF A03; also available SOD HC $2.25 as 003-003-03056-2 CSCL 05B

An alphabetical arrangement of abstracts and indexes available in the Research Information Center (RIC) of the National Institute of Standards and Technology (NIST) is listed by the most current title of the publication. Other information includes description of the abstract or index, RIC holdings, principal sources, publisher or association, corresponding RIC data base and the classification number. A general subject and former title/data base name index follows the main text of the report. GRA

N91-25943# National Inst. of Standards and Technology, Gaithersburg, MD.
NATIONAL BUREAU OF STANDARDS PUBLICATIONS 1977-1987. VOLUME 1: CITATIONS, KEY WORDS, AND ABSTRACTS Final Report, 1977-1987
R. Pardee, E. Gladden, and D. Harris Aug. 1990 1675 p
(PB91-136507; NIST/SP-790-Vol-1) Avail: NTIS HC/MF A99; also available SOD HC $23.50 as 003-003-03042-2 CSCL 05B

Full bibliographic citations, key words, and abstracts for 15,746 National Bureau of Standards (NBS) papers published and entered into the National Institute of Standards and Technology Servics (NIST) collection between 1977 and 1987 are given. Also included are several papers published prior to 1977 but not entered into the NTIS collection until 1977. Author

N91-25944# United Nations Industrial Development Organization, Vienna (Austria).
GUIDELINES FOR SETTING UP DATA BASES ON MEDICINAL PLANTS
Y. R. Chadha 5 Jun. 1990 46 p Presented at the Interregional Meeting on Cooperation among Developing Countries for the Development of the Pharmaceutical Industry, New Delhi, India, 19-22 Mar. 1990
(PB91-137851; UNIDO-ID/WG.502/2/Rev.1(SPEC)) Avail: NTIS HC/MF A03 CSCL 05B

As a follow-up action to the recommendations of the Third Consultation on the Pharmaceutical Industry, and in order to facilitate collection of information by interested countries, an attempt was made by UNIDO to draw up guidelines for the setting-up of data bases on medicinal plants. A short account is provided of existing data bases on the international level. Pertinent information is provided with regard to criteria and infrastructural requirements for setting up a data base at the national level, proposals are included on how to proceed with regional networking of national data bases. A schedule is given for design development and requirements for hardware and software, personnel requirements, budget planning, etc. Additionally, steps involved in the preparation of a monograph on medicinal plants are described and examplified by details given in Senna. GRA

N91-25945# Library of Congress, Washington, DC.
ANTARCTIC BIBLIOGRAPHY, VOLUME 17
G. T. Thuronyi 1990 756 p Sponsored in part by NSF
(PB91-138370; LC-65-61825) Avail: NTIS HC/MF A99; also available SOD HC $41.00 as 003-018-00028-1 CSCL 05B

Abstracts and indexes of current Antarctic literature are given. The material was compiled over a period of 18 months, the cutoff date for inclusion being December 1989. Four indexes are provided:

an author index, a subject index, a geographic index, and a grantee index. Author

N91-25946 Maryland Univ., College Park.
THE DESIGN OF PARTITIONED DISTRIBUTED DATABASE DIRECTORIES Ph.D. Thesis
Jeffery Yan-Ping Chi 1990 200 p
Avail: Univ. Microfilms Order No. DA9110282

A design is proposed of a partitioned distributed data base directory which has the following features. (1) Distributed directories are partitioned into clusters. Each cluster contains replicated local directories of nodes in that cluster. Thus, searching efficiency is improved and updating cost is decreased. (2) A system wide naming convention is not necessary and location transparency is achieved. The partitioned directory structure also provides a generalized model for distributed data base directories. Fully replicated directories and local directories are shown to be special cases of the partitioned design. For a given application environment, an algorithm is presented which derives the optimal directory structure from the generalized model. A partition reorganization model is provided. A reorganization algorithm based on a greedy method also is provided. This algorithm was proven optimal and the complexity of the algorithm was shown to be a polynomial function of cluster size. Partition configuration is the process of resetting up a distributed data base when a new node joins or an antiquated node leaves the data base. The purpose of partition configuration is to bring all the data base directories up to date.
Dissert. Abstr.

N91-25947 University of Technology, Loughborough (England).
PERSONAL INFORMATION SYSTEMS: THE IMPLICATIONS OF JOB AND INDIVIDUAL DIFFERENCES FOR DESIGN Ph.D. Thesis
Susan Coles 1990 369 p
Avail: Univ. Microfilms Order No. BRDX91840

In an age where information has become a crucial commodity, accessing appropriate information quickly is essential to economic success. Developing ways of improving information retrieval is therefore of central concern to human factors and technologists alike. One aspect of information access relates to the ability of individual office workers to manage and retrieve their own information effectively, and this is what the present research addresses. Previous work in the area has been dominated by designing computer interfaces for the average user. This research investigates how people's needs might differ according to circumstance and examines a wider range of design possibilities. Specifically, it sets out to relate retrieval problems (specific information retrieval rather than e.g., browsing or reminding) to job and individual (personality) differences within the general context of personal information management in offices using traditional technologies of paper, filing cabinets and desks. This is achieved by both extensive fieldwork and the use of simulated filing-retrieval systems in a controlled context. The work thus specifies conditions under which retrieval difficulties occur and suggests how they might be causally operative. The findings permit the generation of hypotheses concerning situations where retrieval problems are likely to be critical and novel avenues for improving performance, covering job design, changes to information management techniques (training and equipment design), and personnel selection. Techniques for predicting situations where poor retrieval could occur are put forward, and how methods of improving performance might be applied in offices explored.
Dissert. Abstr.

N91-25948 Syracuse Univ., NY.
A STUDY OF WORD ASSOCIATIONS IN THE NATURAL LANGUAGE EXPRESSIONS OF INFORMATION NEEDS IN AN INFORMATION RETRIEVAL SETTING Ph.D. Thesis
Ruth Ann Palmquist 1990 263 p
Avail: Univ. Microfilms Order No. DA9109612

Two characteristics of a user's language behavior, vocabulary, and structure (defined for this study as the statistical word associations found between vocabulary choices made), are used as indicators of a conceptual or knowledge structure. These characteristics are available in both the inquirer's statement or natural language expression (NLE) of his or her problematic situation and in the natural language portions of the document representations which are selected by the inquirer as useful to that context. These language-use characteristics, vocabulary, and the resulting word associations were examined to determine whether they may be useful in discriminating relevant and non-relevant document representations. Using the automatic application of thesauri, user, and document description, vocabularies were simplified to provide a best possible case for the study. Word associations created by the order and proximity between co-occurring word pairs in both user NLE's and document descriptions with original and simplified vocabularies were determined. These word associations were compared against simple word frequencies for both original and simplified vocabularies. The findings suggest that the user's conceptual structure, as determined using the vocabulary and statistical word associations in the NLE of his or her problematic context, is of limited value in the discrimination of relevant document descriptions from non-relevant ones.
Dissert. Abstr.

N91-25949 Mississippi State Univ., Starkville.
THE MODERATING INFLUENCE OF USER CHARACTERISTICS ON THE RELATIONSHIP BETWEEN USER INVOLVEMENT AND PERCEIVED USEFULNESS OF INFORMATION SYSTEMS Ph.D. Thesis
Bo Kai Wong 1990 209 p
Avail: Univ. Microfilms Order No. DA9108996

Many information system (IS) failures stem from a lack of user acceptance rather than low technical quality. User involvement could be a solution. Although there have been many research efforts directed toward user involvement and system usefulness, they have only scratched the surface of the problem. Most research has assumed a bivariate relationship between involvement and system quality. Conflicting results were often obtained because of these oversimplified relationships. The objectives were to examine the effect of user characteristics and user involvement in the development process on the perceived usefulness of an IS. Specifically, the effect of user involvement on the perceived usefulness was considered, but not strictly as bivariate relationship since a moderating influence of user characteristics was suspected. A mail survey census was attempted with a sampling frame for four hundred and fourty-one industrial organizations that were listed in the 1988 Dun and Brandstreet Million Dollar Directory. The results indicated that the user characteristics, feelings about the existence of procedures to handle conflicts between users and the IS staff, years with the company, and of IS experience, produced moderating effects on the relationship between perceived usefulness and user involvement in the planning and design stage, or in the implementation stage. One conclusion was that IS managers should consider seriously the type of users to be involved in the IS development.
Dissert. Abstr.

N91-25950*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NASA/DOD AEROSPACE KNOWLEDGE DIFFUSION RESEARCH PROJECT. PHASE 3: FACULTY AND STUDENT RESPONDENTS INCLUDING FREQUENCY DISTRIBUTIONS Summary Report No. 9
Thomas E. Pinelli, John M. Kennedy, and Terry F. White Jun. 1991 42 p Prepared in cooperation with Department of Defense, Washington, DC and Indiana Univ., Bloomington
(NASA-TM-104086; NAS 1.15:104086) Avail: NTIS HC/MF A03 CSCL 05B

This project is designed to explore the diffusion of scientific and technical information (STI) throughout the aerospace industry. The increased international competition and cooperation in the industry promises to significantly affect the STI standards of U.S. aerospace engineers and scientists. Therefore, it is important to understand the aerospace knowledge diffusion process itself and its implications at the individual, organizational, national, and

international levels. Examined here is the role of STI in the academic aerospace community. Author

N91-25951# National Aerospace Lab., Tokyo (Japan).
THE DEVELOPMENT OF MAGNETO-OPTIC DISK OPERATION MANAGING PROGRAMS FOR NS SYSTEM
Masako Tsuchiya Nov. 1990 24 p In JAPANESE; ENGLISH summary
(NAL-TR-1086; ISSN-0389-4010) Avail: NTIS HC/MF A03

Magneto-optic disk operation managing programs for the NAL computer system (NS system) are discussed. The programs realize the transference of amount of data between magnetic and magneto-optic disks. One of the important functions of the programs is to convert user's data in variable format to fixed sector format in order to store them in the magneto-optic disk. Another important function is user command languages by which the transference is easily implemented. Experiments have shown that the designed effectiveness of the magneto-optic disk operation managing programs has been achieved. The results imply that utilization and convenience of the NS system are increased. Author

N91-25952*# Old Dominion Univ., Norfolk, VA. Dept. of Computer Science.
PERFORMANCE RELATED ISSUES IN DISTRIBUTED DATABASE SYSTEMS Final Report, period ending 15 May 1991
Ravi Mukkamala Jul. 1991 74 p
(Grant NAG1-1154)
(NASA-CR-185972; NAS 1.26:185972) Avail: NTIS HC/MF A04 CSCL 05B

The key elements of research performed during the year long effort of this project are: Investigate the effects of heterogeneity in distributed real time systems; Study the requirements to TRAC towards building a heterogeneous database system; Study the effects of performance modeling on distributed database performance; and Experiment with an ORACLE based heterogeneous system. For individual titles, see N91-25953 through N91-25958.

N91-25953*# Old Dominion Univ., Norfolk, VA. Dept. of Computer Science.
MEASURING THE EFFECTS OF HETEROGENEITY ON DISTRIBUTED SYSTEMS
Mohamed El-Toweissy, Osman ZeinElDine, and Ravi Mukkamala *In its* Performance Related Issues in Distributed Database Systems Jul. 1991 6 p (For primary document see N91-25952 17-82)
(Grants NAG1-1114; NAG1-1154)
Avail: NTIS HC/MF A04 CSCL 05B

Distributed computer systems in daily use are becoming more and more heterogeneous. Currently, much of the design and analysis studies of such systems assume homogeneity. This assumption of homogeneity has been mainly driven by the resulting simplicity in modeling and analysis. A simulation study is presented which investigated the effects of heterogeneity on scheduling algorithms for hard real time distributed systems. In contrast to previous results which indicate that random scheduling may be as good as a more complex scheduler, this algorithm is shown to be consistently better than a random scheduler. This conclusion is more prevalent at high workloads as well as at high levels of heterogeneity. Author

N91-25954*# Old Dominion Univ., Norfolk, VA. Dept. of Computer Science.
A DISTRIBUTED SCHEDULING ALGORITHM FOR HETEROGENEOUS REAL-TIME SYSTEMS
Osman ZeinElDine, Mohamed El-Toweissy, and Ravi Mukkamala *In its* Performance Related Issues in Distributed Database Systems Jul. 1991 11 p (For primary document see N91-25952 17-82)
(Grants NAG1-1114; NAG1-1154)
Avail: NTIS HC/MF A04 CSCL 05B

Much of the previous work on load balancing and scheduling in distributed environments was concerned with homogeneous systems and homogeneous loads. Several of the results indicated that random policies are as effective as other more complex load allocation policies. The effects of heterogeneity on scheduling algorithms for hard real time systems is examined. A distributed scheduler specifically to handle heterogeneities in both nodes and node traffic is proposed. The performance of the algorithm is measured in terms of the percentage of jobs discarded. While a random task allocation is very sensitive to heterogeneities, the algorithm is shown to be robust to such non-uniformities in system components and load. Author

N91-25955*# Old Dominion Univ., Norfolk, VA. Dept. of Computer Science.
PERFORMANCE ANALYSIS OF STATIC LOCKING IN REPLICATED DISTRIBUTED DATABASE SYSTEMS
Yinghong Kuang and Ravi Mukkamala *In its* Performance Related Issues in Distributed Database Systems Jul. 1991 4 p Previously announced as N91-23974 (For primary document see N91-25952 17-82)
(Grants NAG1-1114; NAG1-1154)
Avail: NTIS HC/MF A04 CSCL 05B

Data replication and transaction deadlocks can severely affect the performance of distributed database systems. Many current evaluation techniques ignore these aspects, because it is difficult to evaluate through analysis and time consuming to evaluate through simulation. A technique is used that combines simulation and analysis to closely illustrate the impact of deadlock and evaluate performance of replicated distributed database with both shared and exclusive locks. Author

N91-25956*# Old Dominion Univ., Norfolk, VA. Dept. of Computer Science.
EFFECTS OF DISTRIBUTED DATABASE MODELING ON EVALUATION OF TRANSACTION ROLLBACKS
Ravi Mukkamala *In its* Performance Related Issues in Distributed Database Systems Jul. 1991 13 p Presented at the Winter Simulation Conference, 1990 Previously announced as N91-23972 (For primary document see N91-25952 17-82)
(Grant NAG1-1154)
Avail: NTIS HC/MF A04 CSCL 05B

Data distribution, degree of data replication, and transaction access patterns are key factors in determining the performance of distributed database systems. In order to simplify the evaluation of performance measures, database designers and researchers tend to make simplistic assumptions about the system. The effect is studied of modeling assumptions on the evaluation of one such measure, the number of transaction rollbacks, in a partitioned distributed database system. Six probabilistic models and expressions are developed for the numbers of rollbacks under each of these models. Essentially, the models differ in terms of the available system information. The analytical results so obtained are compared to results from simulation. From here, it is concluded that most of the probabilistic models yield overly conservative estimates of the number of rollbacks. The effect of transaction commutativity on system throughout is also grossly undermined when such models are employed. Author

N91-25957*# Old Dominion Univ., Norfolk, VA. Dept. of Computer Science.
HETEROGENEOUS DISTRIBUTED DATABASES: A CASE STUDY
Tracy R. Stewart and Ravi Mukkamala *In its* Performance Related Issues in Distributed Database Systems Jul. 1991 7 p (For primary document see N91-25952 17-82)
Avail: NTIS HC/MF A04 CSCL 05B

Alternatives are reviewed for accessing distributed heterogeneous databases and a recommended solution is proposed. The current study is limited to the Automated Information Systems Center at the Naval Sea Combat Systems Engineering Station at Norfolk, VA. This center maintains two databases located on Digital Equipment Corporation's VAX computers running under the VMS operating system. The first data base, ICMS, resides on a VAX11/780 and has been implemented using VAX DBMS, a

CODASYL based system. The second database, CSA, resides on a VAX 6460 and has been implemented using the ORACLE relational database management system (RDBMS). Both databases are used for configuration management within the U.S. Navy. Different customer bases are supported by each database. ICMS tracks U.S. Navy ships and major systems (anti-sub, sonar, etc.). Even though the major systems on ships and submarines have totally different functions, some of the equipment within the major systems are common to both ships and submarines. Author

N91-25958*# Old Dominion Univ., Norfolk, VA. Dept. of Computer Science.
AN INTEGRATED DECISION SUPPORT SYSTEM FOR TRAC: A PROPOSAL
Ravi Mukkamala *In its* Performance Related Issues in Distributed Database Systems Jul. 1991 24 p (For primary document see N91-25952 17-82)
Avail: NTIS HC/MF A04 CSCL 05B

Optimal allocation and usage of resources is a key to effective management. Resources of concern to TRAC are: Manpower (PSY), Money (Travel, contracts), Computing, Data, Models, etc. Management activities of TRAC include: Planning, Programming, Tasking, Monitoring, Updating, and Coordinating. Existing systems are insufficient, not completely automated, manpower intensive, and has the potential for data inconsistency exists. A system is proposed which suggests a means to integrate all project management activities of TRAC through the development of a sophisticated software and by utilizing the existing computing systems and network resources. The systems integration proposal is examined in detail. Author

N91-25959# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Technical Information Panel.
A MANUAL ON THE EVALUATION OF INFORMATION CENTERS AND SERVICES
Jose-Marie Griffiths and Donald W. King (King Research, Inc., Rockville, MD.) Apr. 1991 128 p
(AGARD-AG-310; ISBN-92-835-0614-6) Copyright Avail: NTIS HC/MF A07; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

This manual is a follow-up to AGARD Lecture Series, The Evaluation of Information Centres and Services, LS 160, published in September 1988. It suggests an approach to evaluation which was refined over the last 20 years during involvement in nearly 300 projects involving the planning, evaluation and design of information centers and services. The manual emphasizes the use of evaluation measures, models and methods and includes data and results from actual studies. It also includes a comprehensive bibliography. Author

N91-25960*# National Aeronautics and Space Administration, Washington, DC.
INDEX TO NASA NEWS RELEASES AND SPEECHES, 1989
Apr. 1990 63 p
(NASA-TM-105011; NAS 1.15:105011) Avail: NTIS HC/MF A04 CSCL 05B

This issue of the Index to NASA News Releases and Speeches contains a listing of news releases distributed by the Office of Public Affairs, NASA Headquarters, and a selected listing of speeches presented by members of the Headquarters staff during 1989. The index is arranged in six sections: Subject Index, Personal Names Index, News Release Number Index, Accession Number Index, and Speeches and News Releases. M.G.

N91-25961# Japan Atomic Energy Research Inst., Tokai.
PROCEEDINGS OF THE 1989 SEMINAR ON NUCLEAR DATA
Yutaka Nakajima, ed. Feb. 1990 413 p Seminar held in Tokai, Japan, 16-17 Nov. 1989
(DE90-008196; JAERI-M-90-025; NEANDC(J)-149/U; INDC(JPN)-136/L; CONF-8911182) Avail: NTIS HC/MF A18

The proceedings of the seminar on Nuclear Data are presented. In an oral session, review, and benchmark test of JENDL-3 were presented, which were followed by a lively discussion. The need of nuclear data other than neutron induced reaction data was also presented. In addition, several topical talks were given. In a poster session, 20 papers on evaluation and measurement were presented and discussed. In these proceedings, 34 papers given in the seminar are compiled. DOE

N91-25962# Los Alamos National Lab., NM.
REPORT ON SECURITY ISSUES IN DATABASE SYSTEMS
L. M. Harris Apr. 1991 65 p
(Contract W-7405-eng-36)
(DE91-011101; LA-11938-MS) Avail: NTIS HC/MF A04

This report reviews the procedures and methodology associated with the security evaluation of the Nuclear Weapons Complex Network (NWCnet) WBCN Gateway software. NWCnet, built by the DOE Albuquerque Operations Office and the Computer Integrated Manufacturing (CIM) Program Office, was an early attempt by the DOE to build a complex-wide network for classified data processing. The development of NWCnet broke new ground in DOE computer security management and identified several complex security issues for which new security design and planning techniques were developed. The requirement for a comprehensive security evaluation of each NWCnet service component was established by the CIM Program Office in conjunction with the DOE Office of Safeguards and Security. The goals of the requirement were to establish the network's overall security and to provide a technical basis on which to certify and accredit the network. The DOE Center for Computer Security served as the focal point for this activity, functioned as a liaison between the NWCnet project development team and the security examination teams, and was responsible for coordinating, planning, and conducting the software reviews. In the process of designing and evaluating the WBCN Gateway software, significant knowledge was gained regarding the function of the software and the security evaluation process. Not only did the evaluators learn how to test software in the face of continual change, but they also began to understand how to evaluate the security of the network. This report documents the lessons learned from the evaluation activities and communicates this knowledge. The report focuses on the problems (and solutions) encountered in testing a long-term project undergoing continual, major change. DOE

N91-25963# Oklahoma Geological Survey, Norman.
NATURAL RESOURCES INFORMATION SYSTEM FOR THE STATE OF OKLAHOMA
C. J. Mankin 1990 13 p
(Contract DE-FG22-89BC-14483)
(DE91-008931; DOE/BC-14483/8) Avail: NTIS HC/MF A03

The objective of this research program is to continue developing, editing, maintaining, utilizing, and making publicly available the Natural Resources Information System (NRIS) for the State of Oklahoma. This grant funds that ongoing development work as a follow-on to an earlier grant. The Oklahoma Geological Survey, working with Geological Information Systems at the University of Oklahoma, has undertaken to construct this information system in response to the need for a computerized, centrally located library containing accurate, detailed information on the state's natural resources. Particular emphasis during this phase of development is being placed on computerizing information related to the energy needs of the nation, specifically oil and gas. DOE

N91-25964# EG and G Energy Measurements, Inc., Las Vegas, NV. Remote Sensing Lab.
APPLICATION OF GEOGRAPHIC INFORMATION SYSTEM FOR EMERGENCY MANAGEMENT
R. G. Best, A. L. Guber, and D. H. Kliman 1991 5 p Presented at the 3rd Topical Meeting on Emergency Preparedness and Response, Chicago, 16-19 Apr. 1991
(Contract DE-AC08-88NV-10617)
(DE91-010766; EGG-10617-1115; CONF-910434-1) Avail: NTIS HC/MF A01

One of the responsibilities of the DOE Nevada Operations Office, under the Federal Radiological Emergency Response Plan

(FRERP) and the Aerial Measuring System (AMS) program, is the acquisition and analysis of radiological and associated environmental data. Much of the data are in the form of maps, tabular summaries, and vertical imagery. It is critical that these data be rapidly compiled into a common format in order to make accurate observations and informed decisions. This data management task is both large and complex. Within the Federal Radiological Monitoring and Assessment Center (FRMAC) there is a continuing effort to improve the data management and communication process. The most recent addition to this essential function has been the development and testing of a deployable Digital Image Processing (IP)/Geographic Information System (GIS). To demonstrate the potential of GIS for emergency response, the system was utilized at an interagency post-emergency table top exercise. A geographic database, consisting of 27 coregistered 'layers' of cultural, radiological, satellite image, and environmental data was developed for the area within a 50-mile radius of the River Bend Station in Louisiana. In support of the exercise, maps and real time displays of individual layers and combinations of layers were produced to determine the impact of a hypothetical radiological release and to develop mitigation plans. DOE

N91-25965# Sandia National Labs., Albuquerque, NM.
PROGRESS IN INFORMAL INFORMATION MANAGEMENT: THE CENTRAL TECHNICAL FILE
C. E. Pasterczyk 1991 6 p Presented at the Infotech 1991, Oak Ridge, 22-23 May 1991
(Contract DE-AC04-76DP-00789)
(DE91-010863; SAND-91-0270C; CONF-9105153-1) Avail: NTIS HC/MF A02

One objective of the Sandia Technical Library is to improve the management of unpublished, informal information to respond to (hor ellipsis) information needs and requirements. The Central Technical File (CTF) is an archive of informal documents in Sandia National Laboratories technical programs which has been maintained by the Technical Library since 1952. CTF serves as a corporate memory for the Laboratories. The progress made in the last year to help CTF better meet Library objectives is described. DOE

N91-25966# Sandia National Labs., Albuquerque, NM.
GENERALIZED PRODUCT-TEST-DATA (PTD) MODEL
L. Hernandez, Jr. and P. Flores 1991 15 p Presented at the IDEF User's Group Meeting, Albuquerque, 29 Apr. - 3 May 1991
(Contract DE-AC04-76DP-00789)
(DE91-010873; SAND-91-0202C; CONF-9104218-1) Avail: NTIS HC/MF A03

A data record copy fulfills the role of providing product quality-evidence-data initially in support of product acceptance. Later on, product test data is useful for other purposes as in supporting the performance of system and component reliability and safety assessments. A data record copy can be stored on diverse media such as photographs, paper, electronic, and so forth. However, the scope of the information modeling that is being reported here is primarily limited to electronically stored data. This data can be either variables or attributes data that results from key entering data from manually recorded data forms or automated-tester-generated data. The storage format for electronically stored data can be either flat files or relational databases. The reason for modeling product test data is based on the need to better understand product data requirements. Product identifying data requirements that are based on product definition as documented in product drawings were modeled in this fashion. Since the structure of test data requirements is the same for most products, it is similarly modeled. This effort will lead to development of user defined views of product test data in a distributed data environment. NIAM (Nijssen Information Analysis Method), a natural language based analysis method, is the methodology employed, and validation of the model is being done using PC IAST. DOE

N91-25967# EG and G Rocky Flats, Inc., Golden, CO.
THE ELECTRONIC CONNECTION
M. A. Paliani 1990 8 p
(Contract DE-AC34-90DP-62349)
(DE91-010883; RFP-4475) Avail: NTIS HC/MF A02

EG and G Rocky Flats Inc. is introducing the concept of the Online Information Center (OIC) -- a central, computer based, electronic library which employees can easily reach via their office microcomputers and the plant's Local Area Network (LAN). Supported by user friendly menus and prompts, employees can, in the convenience of their offices, quickly and easily access the most current and reliable versions of the full-text DOE/AL Orders, other selected federal regulations, along with online indexes to a host of plant and offsite information resources. DOE

N91-25968# Los Alamos National Lab., NM.
UPD: A PORTABLE VERSION-CONTROL PROGRAM
R. E. MacFarlane and D. C. George Apr. 1991 21 p
(Contract W-7405-eng-36)
(DE91-011046; LA-12057-MS) Avail: NTIS HC/MF A03

UPD is a version-control code that maintains a history of the changes to a computer program using commands similar to those used by the UPDATE code found on CDC and Cray computer systems. The recorded history of a computer program's evolution is very useful for formal Quality Assurance (QA) programs. UPD is greatly simplified as compared to UPDATE, and it is written in portable FORTRAN. Therefore, it provides a single, uniform version-control system that can run on machines from Cray supercomputers to Sun workstations. DOE

N91-25969# Argonne National Lab., IL.
HIGH-SPEED MLS DATABASES USING THE DATACYCLE ARCHITECTURE
L. Russell 1990 8 p Presented at the 3rd Rome Air Development Center Workshop on Multilevel Secure Databases, Castile, 5-7 Jun. 1990
(Contract W-31-109-eng-38)
(DE91-011172; ANL/CP-72796; CONF-9006336-1) Avail: NTIS HC/MF A02

Although previous research has looked at the problem of providing Microwave Landing System (MLS) database service as an extension of software services, this is not the only system solution. Due to technological advances in fiber optics technology and VLSI circuitry, the problem can be modeled another way, as a network service problem. This is possible because of the development of the datacycle architecture by Bellcore Research. In this report, Section 2 describes the concepts of the architecture. Section 3 describes extensions that need to be made to provide secure communication, and Section 4 looks at the general issues raised by this radical new approach. DOE

N91-25970# California Univ., Berkeley.
AN ARCHITECTURE FOR IDENTIFYING OBJECTS IN MULTIDATABASES
V. M. Markowitz Feb. 1991 11 p Presented at the 1st International Workshop on Interoperability in Multidatabase Systems, Kyoto, Japan, 8-9 Apr. 1991
(Contract DE-AC03-76SF-00098)
(DE91-011865; LBL-29518; CONF-9104235-1) Avail: NTIS HC/MF A03

A multidatabase consists of a collection of independent databases that share and exchange data while preserving their autonomy. Databases contain data about objects and object connections. In this paper, we examine the problem of sharing data on objects in a multidatabase, and present an architecture for identifying and referencing objects across databases of a relational multidatabase. This architecture involves associating every database of a relational multidatabase with two relations that contain the identifiers of local and foreign objects, respectively, and enforcing inner and inter database referential integrity constraints. The proposed architecture has no effect on the original organization and manipulation of data in databases. We examine the main aspects of implementing this architecture with relational database management systems. DOE

N91-25971# National Inst. of Standards and Technology, Gaithersburg, MD.
PROCEEDINGS OF THE OBJECT-ORIENTED DATABASE TASK GROUP WORKSHOP
E. N. Fong and C. W. Thompson Feb. 1991 308 p Workshop held in Atlantic City, NJ, 22 May 1990 Prepared in cooperation with Texas Instruments, Inc., Dallas
(PB91-159723; NISTIR-4503) Avail: NTIS HC/MF A14 CSCL 05B

The workshop attempted to focus on concrete proposals for language or module interfaces, exchange mechanisms, abstract specifications, common libraries, and benchmarks. The proceedings consist of 22 position papers covering various aspects of standardization of object database systems. Author

N91-25217*# Planetary Science Inst., Tucson, AZ.
DEVELOPMENT OF THE DATA BASE FOR NEAR-EARTH RESOURCES Abstract Only
D. R. Davis *In* Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 1 p (For primary document see N91-25203 17-25)
Avail: NTIS HC/MF A08 CSCL 05B

N91-25218*# California Univ., San Diego. Space Inst.
BIBLIOGRAPHIC SEARCH OF THE LITERATURE ON LUNAR PROCESSING Abstract Only
D. R. Criswell *In* Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 1 p (For primary document see N91-25203 17-25)
Avail: NTIS HC/MF A08 CSCL 05B

83 ECONOMICS AND COST ANALYSIS

Includes cost effectiveness studies.

N91-25936*# Morgan State Univ., Baltimore, MD. Dept. of Industrial Engineering.
DEVELOPMENT OF A FUNDING, COST, AND SPENDING MODEL FOR SATELLITE PROJECTS
Jesse P. Johnson *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 34 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 05C

84 LAW, POLITICAL SCIENCE AND SPACE POLICY

Includes NASA appropriation hearings; aviation law; space law and policy; international law; international cooperation; and patent policy.

No abstracts in this category.

85 URBAN TECHNOLOGY AND TRANSPORTATION

Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation.

For related information see also *03 Air Transportation and Safety, 16 Space Transportation,* and *44 Energy Production and Conversion.*

No abstracts in this category.

88 SPACE SCIENCES (GENERAL)

No abstracts in this category.

89 ASTRONOMY

Includes radio, gamma-ray, and infrared astronomy, and astrometry.

N91-25972*# Pennsylvania State Univ., Fogelsville.
ABUNDANCE ANOMALIES OF CARBON AND NITROGEN IN THE IUE SPECTRA OF ALGOL-TYPE INTERACTING BINARIES Final Status Report, 1 Dec. 1988 - 30 Nov. 1990
Carolina P. S. McCluskey 30 Nov. 1990 12 p
(Grant NAG5-1107)
(NASA-CR-187909; NAS 1.26:187909) Avail: NTIS HC/MF A03 CSCL 03A

There are two primary ways in which the products of nucleosynthesis in stellar interiors may appear at the surface of a star. These are mixing and/or loss of the original unburned stellar envelope. In interacting binaries, overflow can contribute dramatically to envelope loss. The simplest abundance anomalies to be expected from nuclear burning of hydrogen, helium, or carbon would be under or over abundances H, He, C, O, Ne, and Mg. In addition, it is expected that carbon is initially severely depleted, while nitrogen is enhanced during hydrogen burning via the CNO cycle in stars above two solar masses. Other, more subtle anomalies are also expected, and elements heavier than magnesium can be created during very late evolution by nuclear burning in massive stars. Consequently, it is expected that abundance anomalies of various kinds should occur in interacting binaries where one or both stars have lost significant amounts of mass. Author

N91-25973 California Univ., San Diego.
HYDROGEN LINE DIAGNOSTICS IN IMPULSIVE FLARES Ph.D. Thesis
Kenneth Grier Gayley 1990 171 p
Avail: Univ. Microfilms Order No. DA9110698

Frequency- and angle-dependent radiative transfer in models of impulsively heated solar flare chromospheres are studied and the resulting hydrogen line diagnostics are investigated. The method handles superthermal flows, and includes partially coherent scattering effects in the Lyman wings. The focus is on diagnostics of chromospheric shocks, condensations, and nonthermal electron heating, in order to guide the interpretation of Lyman alpha and Balmer alpha observations of impulsive events in solar-like chromospheres. The primary conclusions with respect to Lyman alpha diagnostics involve inferring flare temperatures and mass motions from red-shifted and stationary core emission, and extracting information about the flare heating that penetrates the chromosphere from the Stark-redistributed wing emission. How the degree of coherence in the wing scattering affects profile asymmetry, and how this depends on free electron density is considered. The primary conclusions with respect to diagnostics of Balmer alpha are conceptually similar to those of Lyman alpha, although the magnitude of wing brightening and the temperature sensitivity of core emission are modified. Owing to the parallel nature of the Lyman and Balmer diagnostics, compelling conclusions can be drawn from simultaneous line profile observations. When Lyman alpha observations are not available, simultaneous observations in two or more Balmer lines would also be useful. Dissert. Abstr.

N91-25974 Edinburgh Univ. (Scotland).
A MULTICOLOUR SEARCH FOR QUASARS Ph.D. Thesis
Paul Simon Mitchell 1989 354 p
Avail: Univ. Microfilms Order No. BRD-91698

The Edinburgh Multicolour Survey is a data set of approximately 1.3 million images covering a contiguous area of 0.1 steradians at high Galactic latitudes. These data are derived from 130 UK Schmidt photographic plates taken in passbands U, B, V, R, and I in two strips at declinations -5 degrees and 0 degrees, comprising the standard United Kingdom Schmidt Telescope (UKST) fields 789-794 and 861-867 respectively. The aim of the survey is to produce a dataset containing accurate UBVRI information and morphological classification for every image detected in any waveband in the measured area, enabling the discrimination of intrinsically rare populations of objects with non-stellar colours from the foreground of normal Galactic stars. The development of the dataset from its initiation as raw plate material through to the production of the final five-band catalogues, and the selection of quasars over a wide range in redshift are discussed.
Dissert. Abstr.

N91-25924*# State Univ. of New York, Oswego. Dept. of Earth Sciences.
NITROGEN ABUNDANCES FROM UV LINES OF HgMn AND STANDARD LATE-B STARS
Scott W. Roby *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 21-22 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 03A

N91-25984*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
FROM C/MRKOS TO P/HALLEY: 30 YEARS OF COMETARY SPECTROSCOPY Abstract Only
C. Arpigny, F. Dossin, A. Woszczyk, B. Donn, J. Rahe, and Susan Wyckoff (Arizona State Univ., Tempe.) *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 5 (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03A

N91-26012*# Space Telescope Science Inst., Baltimore, MD.
INNER COMA IMAGING OF COMET LEVY (1990c) WITH THE HUBBLE SPACE TELESCOPE Abstract Only
Harold A. Weaver, Michael F. AHearn, W. A. Baum, P. D. Feldman, J. C. Brandt, J. A. Westphal, C. Arpigny, and R. M. Light (California Univ., Santa Cruz.) *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 232 (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03A

90 ASTROPHYSICS

Includes cosmology; celestial mechanics; space plasmas; and interstellar and interplanetary gases and dust.
For related information see also *75 Plasma Physics.*

N91-25975*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
OUTLINE OF THE SOLAR SYSTEM: ACTIVITIES FOR ELEMENTARY STUDENTS
J. Hartsfield and M. Sellers 1990 43 p
(NASA-TM-104965; NAS 1.15:104965; PB91-140814) Avail: NTIS HC/MF A03 CSCL 03B
An introduction to the solar system for the elementary school student is given. The introduction contains historical background, facts, and pertinent symbols concerning the sun, the nine major planets and their moons, and information about comets and asteroids. Aids to teaching are given, including a solar system crossword puzzle with answers. Author

N91-25976 Maryland Univ., College Park.
CARBON AND NITROGEN ABUNDANCE VARIATIONS AMONG GALACTIC GLOBULAR CLUSTER STARS Ph.D. Thesis
Michael Marshall Briley, Jr. 1990 131 p
Avail: Univ. Microfilms Order No. DA9110278
The spectra of stars within Galactic globular clusters spanning a wide range in metallicity (namely 47 Tucanae; (Fe/H) equals -0.8, and NGC 6397; (Fe/H) equals -2.0) were analyzed for differences in molecular features directly related to carbon and nitrogen abundances. A clear pattern of decreasing surface carbon abundance with evolutionary state (brightness) is observed in the red giant branch (RGB) stars of NGC 6397. This is typical of the metal poor clusters, as such trends also were seen by others in M92 and M15, and appears to be due to the mixing of carbon poor nitrogen rich material from the interiors of the stars to their surfaces. The weak G-band phenomenon is found not to be the result of anomalously low carbon abundances, but rather, due to a combination of both carbon abundances typical of RGB tip stars and the lower surface gravities of the asymptotic giant branch (AGB) stars. The carbon and nitrogen variations in the metal rich cluster 47 Tucanae are seen to be somewhat more complicated. A bimodal distribution in the strengths of the 3883 A CN-bands is observed down to M(sub v) is approximately equal to 5 (V is approximately equal to 18), which is well before the cluster main-sequence (MS) turnoff. Such variations occurring before the MS turnoff are very difficult for any theory based on internal mixing to account for. Thus a primordial origin for the CN-band strength differences may be necessary. However, on the basis of 3883 and 4215 A CN-band strengths in subgiant branch (SGB) stars, a difference in the C-12/C-13 ratio may exist between the CN-strong and normal stars. As large amounts of C-13 are expected during C yields N cycle processing, the difference in C-12/C-13 may be the result of varying degrees of mixing, which may additionally explain the CN differences. Observations of the 2.345 micron (13)CO band of four bright RGB stars confirm large amounts of C-13 in the atmospheres of CN-strong RGB tip stars. The CN-normal stars are found to have surprisingly low C-12/C-13 ratios as well, but with slightly less C-13 than their CN-strong counterparts. Dissert. Abstr.

N91-25977 Oregon Univ., Eugene.
TWO STUDIES IN RELATIVISTIC COSMOLOGY: SMOOTHING SPACETIMES VIA RICCI FLOW AND THE BEL-ROBINSON ENERGY IN GOWDY T(SUP 3) X R SPACETIMES Ph.D. Thesis
Martin Andrew Jackson 1990 100 p
Avail: Univ. Microfilms Order No. DA9111119
Two separate studies are contained. The first study is concerned with approximations to cosmological spacetimes. The standard model of cosmology is based on the Friedman-Robertson-Walker spacetimes; these spacetimes are the spatially homogeneous and isotropic solutions of Einstein's equation. The idea of smoothing provides a framework for the use of Friedman-Robertson-Walker spacetimes as approximations to more realistic inhomogeneous spacetimes. An explicit smoothing procedure is examined which is based on smoothing initial data via the Ricci flow equation. The existence and convergence results are proved for the Ricci flows with initial data taken as the spatial three-metrics of certain Bianchi spacetimes and certain Gowdy spacetimes. The results allow consideration of the Bianchi and Gowdy spacetimes as testing grounds for this specific smoothing scheme. The second study pertains to the global existence problem in general relativity. Energy methods are known to be useful in global existence problem; the Bel-Robinson (BR) energy may play the role of an energy norm for general relativity. The evolution of the BR energy was studied in Gowdy T(sup 3) x R spacetimes. A quantity closely related to the BR energy decay monotonically as the spacetime evolves toward the final singularity, except in the special case of Kasner data, for which this quantity is constant.
Dissert. Abstr.

N91-25978 Tufts Univ., Medford, MA.
STRINGS MATTER: DYNAMICS AND EVOLUTION OF COSMIC STRING NETWORKS IN FLAT SPACETIME Ph.D. Thesis
Maria Sakellariadou 1990 108 p
Avail: Univ. Microfilms Order No. DA9109547
This research inquires into the dynamics and evolution of cosmic string networks in flat spacetime. It involves the study of the statistical properties of string networks and the dynamics of long strings, including the scaling density; the fractal nature of

string substructure; and the effectiveness of the gravitational damping mechanism, regarding the long strings' wiggles. Methodologically, it employs both numerical (within the framework of an exact soluble model in flat spacetime) and analytical analyses. The central propositions of this research are a follows: (1) for a string network in equilibrium, when the energy density of the network is low, the dominant part of the string is in the form of closed loops of the smallest allowed size, and a certain critical density the system undergoes a phase transition characterized by formation of very long strings; (2) for an evolving network, the typical curvature radius of long strings, and the characteristic distance between them, are both comparable to the evolution time, and at the same time, long strings possess a significant small-scale structure, which plays an important role in the energy distribution of the produced loops: and (3) gravitational radiation is rather effective in damping the small-scale structure, but only for large amplitude waves. Dissert. Abstr.

N91-25979 Massachusetts Univ., Amherst.
HIGH-SPATIAL RESOLUTION OBSERVATIONS OF CIRCUMSTELLAR DISKS Ph.D. Thesis
Luis Salas-Casales 1990 127 p
Avail: Univ. Microfilms Order No. DA9110210

Current indirect evidence that supports the hypothesis that disks of gas and dust surround young stars in their formation stages is reviewed. Current theoretical models explain this evidence, in particular the observed spectral energy distributions (Lambda)F (sub lambda) varies as Lambda (sup -eta) and luminosities. A consequence of these models is a flared disk structure H(r) varies as r(sup z) that should be observable, yielding a relation between the flaring constant z and the spectral index eta that can be used to propose an evolutionary sequence for the geometry of such disks. High resolution observations were performed in the infrared, aimed imaging scattered radiation from dust embedded in circumstellar disks in solar type pre-main sequence stars. An infrared array recently developed by the Kitt Peak National Observatory was used in combination with the 4 meter telescope. These observations were analyzed using different super-resolution techniques such as image motion suppression, speckle shift-and-add, contrast-ratio analysis, maximum entropy restorations, and speckle interferometry. The results of these studies for the star SCrA are presented as a case study. However, the response function of the telescope has three peaks, with typical separations of half to one arc second, and variations in intensity and position of 30 percent in times as short as one minute. In addition, the noise in long exposure images in the infrared is proportional to the signal, possibly due to the low number of speckles at these wavelengths. Dissert. Abstr.

N91-25980 Maryland Univ., College Park.
EXPERIMENTAL MEASUREMENT OF LOW-ENERGY ANTIPROTONS IN THE COSMIC RADIATION Ph.D. Thesis
Steven Jon Stochaj 1990 90 p
Avail: Univ. Microfilms Order No. DA9110354

Researchers report results from the Low Energy Antiproton Experiment (LEAP), a balloon-borne instrument which was flown in August, 1987. They found a value of 4.2 by 10-6 for the antiproton to proton ratio in the energy range from 120 MeV to 600 MeV at the top of the atmosphere. In particular, this experiment places an upper limit on the flux almost an order of magnitude below the reported flux of Buffington et al. This upper limit allows us to place significant constraints on both the primordial black hole and weakly interacting Majorana Fermion hypothesis, as well as on the low energy processes in more conventional models of galactic cosmic ray antiproton production. Dissert. Abstr.

N91-25981*# Georgia State Univ., Atlanta. Dept. of Physics and Astronomy.
COLLIDING STELLAR WINDS IN O-TYPE CLOSE BINARY SYSTEMS Final Technical Report, Jun. 1989 - Jun. 1991
Douglas R. Gies 1991 8 p
(Grant NAG5-1218)
(NASA-CR-188610; NAS 1.26:188610) Avail: NTIS HC/MF A02 CSCL 03B

A study of the stellar wind properties of O-type close binary systems is presented. The main objective of this program was to search for colliding winds in four systems, AO Cas, iota Ori, Plaskett's star, and 29 UW CMa, through an examination of high dispersion UV spectra from IUE and optical spectra of the H alpha and He I lambda 6678 emission lines. Author

N91-25982*# Lunar and Planetary Inst., Houston, TX.
ABSTRACTS FOR THE INTERNATIONAL CONFERENCE ON ASTEROIDS, COMETS, METEORS 1991 Abstracts Only
1991 280 p Conference held in Flagstaff, AZ, 24-28 Jun. 1991; sponsored by NASA, Barringer Crater Co., Lunar and Planetary Inst., Lowell Observatory, Meteor Crater Enterprises, Inc., Univ. of Northern Arizona, and Geological Survey
(Contract NASw-4574)
(NASA-CR-188609; NAS 1.26:188609; LPI-Contrib-765) Avail: NTIS HC/MF A13 CSCL 03B

Topics addressed include: chemical abundances; asteroidal belt evolution; sources of meteors and meteorites; cometary spectroscopy; gas diffusion; mathematical models; cometary nuclei; cratering records; imaging techniques; cometary composition; asteroid classification; radio telescopes and spectroscopy; magnetic fields; cosmogony; IUE observations; orbital distribution of asteroids, comets, and meteors; solar wind effects; computerized simulation; infrared remote sensing; optical properties; and orbital evolution. For individual titles, see N91-25983 through N91-26018.

N91-25983*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
CHARACTERIZING WATER/ROCK INTERACTION IN SIMULATED COMET NUCLEI VIA CALORIMETRY: TOOL FOR IN-SITU SCIENCE, LABORATORY ANALYSIS, AND SAMPLE PRESERVATION Abstract Only
Judith H. Allton (Lockheed Engineering and Sciences Co., Houston, TX.) and James L. Gooding *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 3 (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03B

Although results from the Giotto and Vega spacecraft flybys of comet P/Halley indicate a complex chemistry for both the ices and dust in the nucleus, carbonaceous chondrite meteorites are still regarded as useful analogs for the rocky components. Carbonaceous chondrites mixed with water enable simulation of water/rock interactions which may occur in cometary nuclei. Three general types of interactions can be expected between water and minerals at sub-freezing temperatures: heterogeneous nucleation of ice by insoluble minerals; adsorption of water vapor by hygroscopic phases; and freezing and melting point depression of liquid water sustained by soluble minerals. Two series of experiments were performed in a differential scanning calorimeter (DSC) with homogenized powders of the following whole-rock meteorites and comparison samples: Allende (CV3), Murchison (CM2), Orgueil (CI), Holbrook (L6), and Pasamonte (eucrite) meteorites as well as on peridotite (PCC-1, USGS), saponite (Sap-Ca-1, CMS), montmorillonite (STx-1, CMS), and serpentine (Franciscan Formation, California). Results are briefly discussed. Author

N91-25984*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
FROM C/MRKOS TO P/HALLEY: 30 YEARS OF COMETARY SPECTROSCOPY Abstract Only **c89**
C. Arpigny, F. Dossin, A. Woszczyk, B. Donn, J. Rahe, and Susan Wyckoff (Arizona State Univ., Tempe.) *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 5 (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03A

An Atlas of Cometary Spectra was compiled, as a sequel to

the well-known Atlas published by Swings and Haser in 1956. The new atlas comprises some 400 reproductions of cometary spectra secured in the world's largest observatories during the three decades or so from the passage of comet Mrkos 1957 V, for which the very first high-dispersion spectrum was obtained, to the return of Halley's comet. The illustrations refer to 40 different comet apparitions; they are grouped into a set of 186 loose 11 x 14 in. plates, while the texts, comments, and relevant data are given in a separate booklet. The main purpose of this atlas is to show in detail the tremendous progress which was achieved in cometary spectroscopy during the period covered, essentially thanks to the use of high-resolution coude spectrographs and large telescopes, the considerable extension of the observed wavelength range, and the advent of electronic detectors. It is divided into two parts. Part 1, which contains about two-thirds of the selected material, presents photographic spectra, while electronically recorded spectra covering the vacuum ultraviolet, through the optical, infrared, and radio regions appear in Part 2.
Author

N91-25985*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
LOW-PRESSURE CLATHRATE-HYDRATE FORMATION IN AMORPHOUS ASTROPHYSICAL ICE ANALOGS Abstract Only
D. F. Blake, L. J. Allamandola, S. Sandford, D. Hudgins, and F. Freund *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 23 (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03B

In modeling cometary ice, the properties of clathrate hydrates were used to explain anomalous gas release at large radial distances from the Sun, and the retention of particular gas inventories at elevated temperatures. Clathrates may also have been important early in solar system history. However, there has never been a reasonable mechanism proposed for clathrate formation under the low pressures typical of these environments. For the first time, it was shown that clathrate hydrates can be formed by warming and annealing amorphous mixed molecular ices at low pressures. The complex microstructures which occur as a result of clathrate formation from the solid state may provide an explanation for a variety of unexplained phenomena. The vacuum and imaging systems of an Hitachi H-500H Analytical Electron Microscope was modified to study mixed molecular ices at temperatures between 12 and 373 K. The resulting ices are characterized by low-electron dose Transmission Electron Microscopy (TEM) and Selected Area Electron Diffraction (SAED). The implications of these results for the mechanical and gas release properties of comets are discussed. Laboratory IR data from similar ices are presented which suggest the possibility of remotely observing and identifying clathrates in astrophysical objects.
Author

N91-25986*# Southwest Research Inst., San Antonio, TX.
MODELING THE COMA OF 2060 CHIRON Abstract Only
D. C. Boice, I. Konno, S. Alan Stern, and W. F. Huebner *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 26 (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03B

Observations of comet-like activity and a resolved coma have established that 2060 Chiron is a comet. Determinations of its radius range from 65 to 200 km. This unusually large size for a comet suggests that the atmosphere of Chiron is intermediate to the tightly bound, thin atmospheres typical of planets and satellite and the greatly extended atmospheres in free expansion typical of cometary comae. Under certain conditions it may gravitationally bind an atmosphere that is thick compared to its size, while a significant amount of gas escapes to an extensive exosphere. These attributes coupled with reports of sporadic outbursts at large heliocentric distances and the identification of CN in the coma make Chiron a challenging object to model. Simple models of gas production and the dusty coma were recently presented but a general concensus on many basic features has not emerged. Development was begun on a more complete coma model of Chiron. The objectives are to report progress on this model and give the preliminary results for understanding Chiron.
Author

N91-25987*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
CCD PHOTOMETRY OF 2060 CHIRON, 1991 JANUARY Abstract Only
B. J. Buratti, R. L. Marcialis, E. S. Howell, and M. C. Nolan (Arizona Univ., Tucson.) *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 33 (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03B

Observations of 2060 Chiron was performed on 7 to 8 Jan. 1991 with the Mt. Palomar 1.52 m telescope in the Gunn-R passband. On-chip field stars were used to perform differential reductions. The repeatability of the 5.9 hour light curve was excellent, both within a night and from night to night. No evidence for short-term secular variations similar to those seen last year by both Luu and Jewitt (1990) and Buratti and Dunbar (1991) is seen in the new light curve. Chiron's rotational light curve appears strikingly similar to that obtained a year earlier by Luu and Jewitt (1990), both in amplitude and shape. Both light curves show strongly correlated changes over a timescale of perhaps 15 minutes. These same features were marginally visible in the 1986 light curve. Such behavior is believed to be evidence that Chiron may be more aspherical than the 4 percent intensity variation might otherwise indicate, and favors a viewing geometry where the subearth latitude is rather low. Chiron was much fainter in 1985, when a partial light curve was obtained by Marcialis. Due to the lower sampling rate of these early data, no conclusions can be made regarding the high-frequency light curve structure back then. All three of these light curves differ significantly from that obtained by Buratti and Dunbar (1991), one week before the observations of Luu and Jewitt. The Chiron field was calibrated using Landolt standards on Ut 15 Mar. 1991. A mean R-magnitude of 15.6 + or - 0.1 was found. Variability of 2060 Chiron was demonstrated over timescales of minutes, hours, and years. An intense campaign was urged to monitor the photometric behavior of Chiron throughout the 1990s.
Author

N91-25988*# Lowell Observatory, Flagstaff, AZ.
CHIRON: EVIDENCE FOR HISTORIC COMETARY ACTIVITY Abstract Only
Schelte J. Bus, Edward Bowell, S. Alan Stern, and Michael F. AHearn (Maryland Univ., College Park.) *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 34 (For primary document see N91-25982 17-90)
(Grant NAGw-1470)
Avail: NTIS HC/MF A13 CSCL 03B

The non-asteroidal brightening of (2060) Chiron, first noted by Tholen in 1988 is now ascribed to cometary activity. Photometry since 1988 has revealed a broad surge in brightness that peaked in 1989 about 1.0 mag above the brightness in the mid-1980s. The surge is evidently due to sporatic formation of dust coma, which is itself driven by the presence of extremely volatile ices at or near the surface. CN emission was recently reported. Since Chiron is now nearing perihelion, there is interest in determining whether it has exhibited anomalous brightening in the past, particularly at greater heliocentric distances. Photographic plates dating back to 1895 are known to contain images of Chiron. Using some of these archival material, the initial results are presented for a project to determine Chiron's brightness history over orbital timescales. A particularly homogeneous and high-quality set of plates taken prior to and around the time of Chiron's discovery in Oct. 1977 at the 1.2 m Oschin Schmidt telescope at Mt. Palomar Observatory were examined. Images of Chiron were identified and digitized using a PDS microdensitometer, and images of field stars around Chiron were both similarly digitized and photometrically calibrated using recently acquired B and V band CCD frames. As a result of the present work, eleven new data, including estimated errors, were added between 1969 and 1977. The implications that

Chiron can be active at any heliocentric distance in its present orbit suggest that the active volatile is either N2, CH4, or CO, and that a substantial degree of mantling may have developed. Further historical data is presented, the error bars discussed, and possible mechanisms suggested for the observed activity.
Author

N91-25989*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
THE DUST COMA OF COMET AUSTIN (1989c1) Abstract Only
Humberto Campins, Stephen C. Tegler (Florida Univ., Gainesville.), C. M. Telesco, and C. Benson *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 35 (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03B

Thermal-infrared (10 and 20 micron) images of Comet Austin were obtained on UT 30.6 Apr., 1.8, 2.8, and 3.6 May 1990. The NASA-Marshall Space Flight Center 20 pixel bolometer array at the NASA 3 meter Infrared Telescope Facility in Hawaii was used. The 10.8 micron (FWHM = 5.3 microns) maps were obtained with maximum dimensions of 113 arcsec (57,500 km) in RA and 45 arcsec (23,000 km) in declination, with a pixel size of 4.2 x 4.2 arcsec. A smaller, 45 x 18 arcsec, map was obtained in the 19.2 micron (FWHM = 5.2 microns) bandpass. At the time of these observations Comet Austin's heliocentric and geocentric distances were 0.7 and 0.5 AU respectively. The peak flux density (within the brightest pixel) was 23 + or - 2 Janskys for the first three dates and only marginally lower the last day; i.e., within the observational uncertainties no evidence was found for day-to-day variability like that observed in Comet Halley. A dynamical analysis of the morphology of the extended dust emission is used to constrain the size distribution and production rate of the dust particles. The results of this analysis are compared with similar studies carried out on comets P/Giacobini-Zinner, P/Brorsen-Metcalf, P/Halley, P/Tempel 2, and Wilson (1987). Author

N91-25990*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
HUT OBSERVATIONS OF CARBON MONOXIDE IN THE COMA OF COMET LEVY (1990c) Abstract Only
P. D. Feldman, A. F. Davidsen, W. P. Blair, C. W. Bowers, W. V. Dixon, S. T. Durrance, R. C. Henry, G. A. Kriss, J. Kruk, and H. W. Moos (Johns Hopkins Univ., Baltimore, MD.) et al *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 60 (For primary document see N91-25982 17-90)
(Contract NAS5-27000)
Avail: NTIS HC/MF A13 CSCL 03B

Observations of comet Levy (1990c) were made with the Hopkins Ultraviolet Telescope during the Astro-1 Space Shuttle mission on 10 Dec. 1990. The spectrum, covering the wavelength range 415 to 1850 A at a spectral emission of 3 A (in first order), shows the presence of carbon monoxide and atomic hydrogen, carbon, and sulfur in the coma. Aside from H I Lyman-beta, no cometary features are detected below 1200 A, although cometary O I and O II would be masked by the same emissions present in the day airglow spectrum. The 9.4 x 116 arcsec aperture corresponds to 12,000 x 148,000 km at the comet. The derived production rate of CO relative to water, 0.13 + or - 0.02, compared with the same ratio derived from IUE observations (made in Sep. 1990) which sample a much smaller region of the coma, 0.04 + or - 0.01, suggests the presence of an extended source of CO, as was found in comet Halley. Upper limits on Ne and Ar abundance are within an order of magnitude or solar abundances. Author

N91-25991*# Arizona Univ., Tucson. Lunar and Planetary Lab.
A CCD SPECTRUM AND PRODUCTION RATES FOR COMET P/TEMPLE 2 Abstract Only
Uwe Fink and Michael Hicks *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 65 (For primary document see N91-25982 17-90)
(Grant NAGw-1549)
Avail: NTIS HC/MF A13 CSCL 03B

Now that comet P/Tempel 2 has been resurrected as the primary target for the CRAF mission, an analysis is presented of a 20 minute exposure taken Oct. 9, 1988. The comet displays a typical spectrum with no unusual omissions or additions. The comet therefore appears to be quite suitable for detailed spacecraft study as a representative object. Strong emissions by C2, NH2, CN, and OI sup 1 D are exhibited. Compared to the emissions, the continuum is moderately strong but appears somewhat weaker than for P/Halley. Production rates for H2O (from OI sup 1 D) and the parent of C2, NH2, and CN is presented and compared to P/Halley. Author

N91-25992*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
THE P/HALLEY: SPATIAL DISTRIBUTION AND SCALE LENGTHS FOR C2, CN, NH2, AND H2O Abstract Only
Uwe Fink, Michael Combi (Michigan Univ., Ann Arbor.), and Michael A. DiSanti *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 66 (For primary document see N91-25982 17-90)
(Grant NAGw-1549)
Avail: NTIS HC/MF A13 CSCL 03B

From P/Halley long slit spectroscopic exposures on 12 dates, extending from Oct. 1985 to May 1986, spatial profiles were obtained for emissions by C2, CN, NH2, and OI(1D). Haser model scale lengths were fitted to these data. The extended time coverage allowed the checking for consistency between the various dates. The time varying production rate of P/Halley severely affected the profiles after perihelion, which is shown in two profile sequences on adjacent dates. Because of the time varying production rate, it was not possible to obtain reliable Haser model scale lengths after perihelion. The pre-perihelion analysis yielded Haser model scale lengths of sufficient consistency that they can be used for production rate determinations, whenever it is necessary to extrapolate from observed column densities within finite observing apertures. Results of scale lengths reduced to 1 AU are given and discussed. Author

N91-25993*# Rensselaer Polytechnic Inst., Troy, NY. Dept. of Geology.
VARIATIONS IN MAGMATIC PROCESSES AMONG IGNEOUS ASTEROIDS Abstract Only
M. J. Gaffey *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 71 (For primary document see N91-25982 17-90)
(Grants NAGw-642; NSF AST-90-12180)
Avail: NTIS HC/MF A13 CSCL 03B

Six asteroid classes (types V, E, A, R, M, S) are composed primarily of differentiated assemblages produced by igneous processes within their parent planetesimals. These are identified by surface materials which deviate from a chondritic composition to a degree that require igneous chemical fractionation processes. There are large variations among these igneous asteroids in the peak temperatures attained, in the efficiency of magmatic phase separation, and in the depth within the original parent body exposed at the present surface. These variations provide important constraints on the nature of asteroidal heating events, on the differentiation processes within small planetary bodies, and on the disruption of those parent bodies. Variations due to depth within the parent body and due to degree of magmatic differentiation are detailed. Author

N91-25994*# Arizona Univ., Tucson. Lunar and Planetary Lab.
DEIMOS: A FEATURELESS ASTEROID-LIKE SPECTRUM Abstract Only **c91**
W. M. Grundy and Uwe Fink *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 77 (For primary document see N91-25982 17-90)

(Grants NAGw-1549; NGT-50661)
Avail: NTIS HC/MF A13 CSCL 03B

High quality CCD spectra were obtained of Deimos from 0.5 to 1.0 micron at a spectral resolution of 15A at the time of the 1988 Mars opposition. The data acquisition and reduction methods allowed the quantitative prevention of scattered light from Mars contaminating the spectra. Solar analog stars BS560, BS2007, and BS8931 were observed the same night to allow removal of telluric absorptions. The ratio spectrum of Deimos has a red slope, increasing in reflectance by a factor of approx. 50 pct. over the one octave wavelength interval observed. Other than this slope, the spectrum is remarkably featureless. The absence of absorption bands in the spectrum of Deimos is in marked contrast with the spectra of Martian surface materials. No trace of the Fe(2+) charge transfer absorption band around 1 micron is observed, which rules out the presence of significant quantities of minerals such as the pyroxenes or olivine at the surface of Deimos. The featureless red spectrum of Deimos appears to be consistent with a surface composition of fine grained carbonaceous chondrite type material. An analysis is presented of the spectrum of Deimos which makes use of the Hapke scattering surface model. Author

N91-25995*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
NEAR-EARTH ASTEROID DISCOVERY RATE REVIEW Abstract Only c91
Eleanor F. Helin *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 90 (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03B

Fifteen to twenty years ago the discovery of 1 or 2 Near Earth Asteroids (NEAs) per year was typical from one systematic search program, Palomar Planet Crossing Asteroid Survey (PCAS), and the incidental discovery from a variety of other astronomical program. Sky coverage and magnitude were both limited by slower emulsions, requiring longer exposures. The 1970's sky coverage of 15,000 to 25,000 sq. deg. per year led to about 1 NEA discovery every 13,000 sq. deg. Looking at the years from 1987 through 1990, it was found that by comparing 1987/1988 and 1989/1990, the world discovery rate of NEAs went from 20 to 43. More specifically, PCAS' results when grouped into the two year periods, show an increase from 5 discoveries in the 1st period to 20 in the 2nd period, a fourfold increase. Also, the discoveries went from representing about 25 pct. of the world total to about 50 pct. of discoveries worldwide. The surge of discoveries enjoyed by PCAS in particular is attributed to new fine grain sensitive emulsions, film hypering, more uniformity in the quality of the photograph, more equitable scheduling, better weather, and coordination of efforts. The maximum discoveries seem to have been attained at Palomar Schmidt. Author

N91-25996*# York Univ., Toronto (Ontario).
THE 1990 MB: THE FIRST MARS TROJAN Abstract Only c91
Kimmo A. Innanen, Seppo Mikkola, Edward Bowell, Karri Muinonen, and Eugene M. Shoemaker (Geological Survey, Flagstaff, AZ.) *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 96 (For primary document see N91-25982 17-90)
(Grant NAGw-1470)
Avail: NTIS HC/MF A13 CSCL 03B

Asteroid 1990 MB was discovered by D. H. Levy and H. E. Holt during the course of the Mars and Earth Crossing Asteroid and Comet Survey. An orbit based on a 9 day arc and the asteroid's location near Mars' L5 (trailing Lagrangean) longitude led E. Boswell to speculate that it might be in 1:1 resonance with Mars, analogous to the Trojan asteroids of Jupiter. Subsequent observations strengthened the possibility, and later calculations confirmed it. Thus 1990 MB is the first known asteroid in 1:1 resonance with a planet other than Jupiter. The existence of 1990 MB (a small body most likely between 2 and 4 km in diameter) provides remarkable confirmation of computer simulations. These self consistent n-body simulations demonstrated this sort of stability for Trojans of all the terrestrial planets over at least a 2 million year time base. The discovery of 1990 MB suggests that others of similar or smaller diameter may be found. Using hypothetical populations of Mars Trojans, their possible sky plane distributions were modeled as a first step in undertaking a systematic observational search of Mars' L4 and L5 libration regions.
Author

N91-25997*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
DUST PARTICLES FROM COMETS AND ASTEROIDS COLLECTED AT THE EARTH'S ORBIT: PARENT-DAUGHTER RELATIONSHIPS Abstract Only
A. A. Jackson (Lockheed Engineering and Sciences Co., Houston, TX.) and H. A. Zook *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 100 (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03B

The relative contributions of comets and asteroids to the reservoir of dust in the interplanetary medium is not well known. There are direct observations of dust released from comets and there is evidence to associate the IRAS dust bands with possible collisions of Asteroids in the main belt. It is believed that one may combine lab analysis of the physics and chemistry of captured particles with orbital data in order to identify comet and asteroid parent bodies. It is possible to use the collected orbits of the dust to connect with its source in two ways. One is to consider the long time orbit evolution of the dust under Poynting-Robertson drag. The other is to look at the prompt orbit change of dust from comets onto trajectories that intersect the earth's orbit. In order to characterize the orbits of dust particles evolved over a long period of time, a study of its orbital evolution was undertaken. Various parameters associated with these dust orbits as they cross the Earth's orbit were considered in order to see if one may discriminate between particles evolved from comets and asteroids. The method was to calculate by a numerical procedure the orbits of dust particles after they left their parent bodies. It appears that as the particles pass the Earth's orbit, asteroidal grains and cometary grains can be differentiated on the basis of their measured orbital eccentricities even after much planetary perturbation. Broad parent daughter associations can be made on this basis from measurement of their trajectories intercepted in earth orbit.
Author

N91-25998*# California Univ., Davis. Dept. of Chemistry.
COMETARY IMPLICATIONS OF THE INTERNAL ENERGY DISTRIBUTIONS OF THE C2 AND C3 RADICALS PRODUCED IN THE PHOTOLYSIS OF THE C2H AND C3H2 Abstract Only
William M. Jackson, Yihan Bao, Randall S. Urdahl, Xueyu Song, Jai Gosine, and Chi Luu *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 101 (For primary document see N91-25982 17-90)
(Grant NAGw-903)
Avail: NTIS HC/MF A13 CSCL 03B

The C2 and C3 radicals are prominent emission in the visible region of cometary spectra. Observational evidence exists that suggests these radicals are formed as granddaughter fragments in the photolysis of more stable molecules. Likely candidates for these parent molecules ar C2H2, C3H4 (allene), and CH3C2H (propyne). Recent laboratory studies were performed on all of these parent molecules and they indicate that they can indeed produce the observed cometary radicals. In the case of C2H2, the laboratory evidence suggest that C2 is formed via the following mechanisms: (1) C2H2 + photon(193 nm) yields C2H + H; and (2) C2H + photon(193 nm) yields C2 + H. Evidence is presented to show that the C2 radical produced in the second reaction occurs in a variety of electronic, vibrational, and rotational states. It is argued that this is a result of conical intersections in the potential energy curves and the density of states associated with these curves. Since this is a property of the C2H radical similar initial product state distributions are expected to occur in comets. This means that any models of the C2 emission may have to start off with rotationally excited C2 radicals in both the singlet and the

triplet manifolds. When C3H4 (allene) and CH3C2H (propyne) were photolyzed, the C3 radical is formed. In the allene case, laboratory evidence shows that the C3 radical is formed via the following mechanism: (1) C3H4 + photon(193 nm) yields C3H2 + H2; and (2) C3H2 + photon(193 nm) yields C3 + H2. More C3 is formed in the case of allene than in the propyne case, even though the absorption cross section for propyne is a factor of 2 larger. This suggests that competing dissociation pathways are present during the photolysis of propyne that are not available to allene. The observed quantum state distributions of the C3 product were the same for both parent molecules, indicating that the same intermediate state is involved. These observations can be understood if the excited propyne formed in the initial absorption step isomerizes to excited allene before it dissociates to the same daughter compound. This postulate was tested by comparing RRKM calculations of the isomerization rate of excited propyne versus the decomposition rate to other products. Author

N91-25999*# California Univ., Davis. Dept. of Chemistry.
FORMATION OF IONS AND RADICALS FROM ICY GRAINS IN COMETS Abstract Only
William M. Jackson, Christopher Gerth, and Charles Hendricks (Lawrence Livermore National Lab., CA.) *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 102 (For primary document see N91-25982 17-90)
(Grant NAGw-1144)
Avail: NTIS HC/MF A13 CSCL 03B

Ion and radical formation in comets are thought to occur primarily by photodissociation of gas phase molecules. Experimental evidence and theoretical calculations are presented that show that some of the radical and ions can come directly from ice grains. The experimental evidence suggest that if the frozen molecules on the surface of grains undergo direct dissociation then they may be able to release radicals directly in the gas phase. If the molecules undergo predissociation it is unlikely that they will release radicals in the gas phase since they should be quenched. Calculations of this direct photodissociation mechanism further indicate that even if the parent molecule undergoes direct dissociation, the yield will not be high enough to explain the rays structure in comets unless the radicals are stored in the grains and then released when the grain evaporates. Calculations were also performed to determine the maximum number of ions that can be stored in an icy grain's radius. This number is compared with the ratio of the ion to neutral molecular density. The comparison suggests that some of the ions observed near the nucleus of the comet could have originally been present in the cometary nucleus. It is also pointed out that the presence of these ions in icy grains could lead to radical formation via electron recombination. Finally, an avalanche process was evaluated as another means of producing ions in comets.
Author

N91-26000*# Arizona Univ., Tucson. Lunar and Planetary Lab.
EVALUATING SOME COMPUTER ENHANCEMENT ALGORITHMS THAT IMPROVE THE VISIBILITY OF COMETARY MORPHOLOGY Abstract Only
S. M. Larson and C. D. Slaughter (Photometrics, Inc., Tucson, AZ.) *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 131 (For primary document see N91-25982 17-90)
(Grant NAGw-1974)
Avail: NTIS HC/MF A13 CSCL 03B

The observed morphology of cometary comae is determined by ejection circumstances and the interaction of the ejected material with the local environment. Anisotropic emission can provide useful information on such things as orientation of the nucleus, location of active areas on the nucleus, and the formation of ion structure near the nucleus. However, discrete coma features are usually diffuse, of low amplitude, and superimposed on a steep intensity gradient radial to the nucleus. To improve the visibility of these features, a variety of digital enhancement algorithms were employed with varying degrees of success. They usually produce some degree of spatial filtering, and are chosen to optimize visibility of certain detail. Since information in the image is altered, it is important to understand the effects of parameter selection and processing artifacts can have on subsequent interpretation. Using the criteria that the ideal algorithm must enhance low contrast features while not introducing misleading artifacts (or features that cannot be seen in the stretched, unprocessed image), the suitability of various algorithms that aid cometary studies were assessed. The strong and weak points of each are identified in the context of maintaining positional integrity of features at the expense of photometric information. Author

N91-26001*# Harvard-Smithsonian Center for Astrophysics, Cambridge, MA.
A CCD COMPARISON OF OUTER JOVIAN SATELLITES AND TROJAN ASTEROIDS Abstract Only **c91**
Jane X. Luu *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 141 (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03B

The eight small outer Jovian satellites are not as well known as the brighter, more illustrious Galilean satellites. They are divided into two groups, each containing four satellites; the inner group travels in prograde orbits while the outer group travels in retrograde orbits. From the distinct orbital characteristics of the two groups, most of the theories of their origin involve the capture and breakup of two planetesimals upon entry into the atmosphere of proto-Jupiter. Their proximity to the Trojans asteroids has led to conjectures of a link between them and the Trojans. However, Tholen and Zellner (1984) found no red spectrum among six of the satellites and postulated that they were all C-type objects; therefore, they were unlikely to be derivatives of the Trojan population. Charge-coupled device (CCD) photometry and spectroscopy of the eight outer Jovian satellites obtained from 1987 to 1989 and a comparison between these eight satellites and the Trojan asteroids are presented. Author

N91-26002*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
NEAR-INFRARED REFLECTANCE SPECTRA-APPLICATIONS TO PROBLEMS IN ASTEROID-METEORITE RELATIONSHIPS Abstract Only
Lucy A. McFadden, Alan Chamberlin (California Univ., San Diego, La Jolla.), and Faith Vilas *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 150 (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03B

Near-infrared spectral reflectance data were collected at the Infrared Telescope Facility (IRTF) at Mauna Kea Observatories in 1985 and 1986 for the purpose of searching the region near the 3:1 Kirkwood gap for asteroids with the spectral signatures of ordinary chondrite parent bodies. Twelve reflectance spectra are observed. The presence of ordinary chondrite parent bodies among this specific set of observed asteroids is not obvious, though the sample is biased towards the larger asteroids in the region due to limitations imposed by detector sensitivity. The data set, which was acquired with the same instrumentation used for the 52-color asteroid survey (Bell et al., 1987), also presents some additional findings. The range of spectral characteristics that exist among asteroids of the same taxonomic type is noted. Conclusions based on the findings are discussed. Author

N91-26003*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
INFRARED REMOTE SENSING OF COMETARY PARENT VOLATILES FROM THE GROUND, AIR, AND SPACE Abstract Only
Michael J. Mumma, Michael A. DiSanti, Susan Hoban, and Dennis C. Reuter *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 155 (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03B

A balanced view of the present generation of infrared instruments for cometary compositional studies is presented. Ground-based instruments are compared with airborne and spaceborne capabilities. An attempt to give examples of the unique science achievable with each is made, and particular emphasis is on the unique aspects of a dedicated Cometary Composition Telescope in earth orbit for investigating the chemical and structural heterogeneity of the cometary nucleus. Author

N91-26004*# Lowell Observatory, Flagstaff, AZ.
THE 15 YEARS OF COMET PHOTOMETRY: A COMPARATIVE ANALYSIS OF 80 COMETS Abstract Only
David J. Osip, David G. Schleicher, Robert L. Millis, Michael F. Ahearn, and Peter V. Birch (Perth Observatory, Bickley, Australia) *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 160 (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03B

In 1976, a program of narrowband photometry of comets was initiated that has encompassed well over 400 nights of observations. To date, the program has provided detailed information on 80 comets, 11 of which were observed during multiple apparitions. The filters (initially isolating CN, C2, and continuum and later including C3, OH, and NH) as well as the detectors used for the observations were changed over time, and the parameters adopted in the reduction and modeling of the data have likewise evolved. Accordingly, we have re-reduced the entire database and have derived production rates using current values for scalelengths and fluorescence efficiencies. Having completed this task, the results for different comets can now be meaningfully compared. The general characteristics that are discussed include ranges in composition (molecular production rate ratios) and dustiness (gas production compared with Af(rho)). Additionally an analysis of trends on how the production rates vary with heliocentric distance and on pre- and post-perihelion asymmetries in the production rates of individual comets. Possible taxonomic groupings are also described. Author

N91-26005*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
THE CONTRIBUTION OF METHANOL TO THE 3.4 MICRON FEATURE IN COMETS Abstract Only
Dennis C. Reuter and Michael J. Mumma *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 175 (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03B

With the advent of improved detectors and improved moderate resolution spectrometers several interesting features have been seen in the infrared spectra of comets. In particular, an emission excess at 3.52 microns was observed in several comets, and has recently been tentatively assigned to the nu 3 band of methanol (CH3OH). Using a developed model it is possible to calculate the relative strengths of the CH3OH features. The 3.52 microns emission strengths were used in a number of comets to retrieve methanol amounts, and the model was used to predict the fraction of the 3.4 micron flux which is contributed by the species. Implications for cometary formation are discussed. Author

N91-26006*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
NUCLEUS MODEL FOR PERIODIC COMET TEMPEL 2 Abstract Only
Zdenek Sekanina *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 192 (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03B

Observational data obtained primarily during 1988 are analyzed and synthesized to develop a comprehensive physical model for the nucleus of Periodic Comet Tempel 2, one of the best studied members of Jupiter's family of short-period comets. It is confirmed that a previous investigation provided reliable information on the comet's spin-axis orientation, which implies and obliquity of 54 degrees of the orbit plane to the equatorial plane and which appears to have varied little - if at all - with time. This conclusion is critical for fitting a triaxial ellipsoid to approximate the figure of the nucleus. Author

N91-26007*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
RANDOMIZATION OF PARTICLE MOTIONS AND THE OBSERVED MORPHOLOGY OF COMETARY HEADS Abstract Only
Zdenek Sekanina *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 193 (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03B

A great diversity is known to exist in the coma morphology of comets. In particular, some comets show much structural detail in their heads (such as jets, halos, fans, plumes, streamers), while others have completely structureless comas. Obvious questions arise as to why is this so and what does the presence or absence of features tell us about the emission processes on cometary nuclei. In an effort to investigate these problems, a computer code that generates synthetic images of dust comets was modified by introducing random perturbations into motions of ejected particles. It is noted that the introduction of perturbations has made the computer generated images simulate the appearance of comets quite faithfully and that by increasing the perturbations beyond a certain limit it has been possible to erase the coma morphology diagnostic of the details of the ejection process. It is proposed that the degree of collimation of an ejecta flow from discrete active sources on the nucleus surface and possible emissions of dust coma. Molecules of comet gases that radiate in the spectral region employed (and whose velocity distribution is much more chaotic than that of dust particles) and limited atmospheric seeing likewise contribute to blurring structural detail in ground-based imaging observation of comets. The absence of discrete features in the coma does no means imply the absence of localized sources of activity on the nucleus. Author

N91-26008*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
SUBLIMATION RATES OF CARBON MONOXIDE AND CARBON DIOXIDE FROM COMET NUCLEI AT LARGE DISTANCES FROM THE SUN Abstract Only
Zdenek Sekanina *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 194 (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03B

One of the more attractive among the plausible scenarios for the major emission event recently observed on Comet Halley at a heliocentric distance of 14.3 AU is activation of a source of ejecta driven by an icy substance much more volatile than water. As prerequisite for the forthcoming detailed analysis of the imaging observations of this event, a simple model is proposed that yields the sublimation rate versus time at any location on the surface of a rotating cometary nucleus for two candidate ices: carbon monoxide and carbon dioxide. The model's variable parameters are the comet's heliocentric distance r and the Sun's instantaneous zenith angle z. Author

N91-26009*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
A CENSUS OF THE ASTEROID BELT Abstract Only **c91**
E. F. Tedesco and G. J. Veeder *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 218 Sponsored in part by AFGL (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03B

Observations obtained by the Infrared Astronomical Satellite (IRAS) during its ten month mission in 1983 were originally processed by the Asteroid Data Analysis System (ADAS) to search for 3453 asteroids with known orbital elements as of September 1985. A total of 1811 had one or more observations of sufficient reliability to be accepted. These results were released in October

1986. Recently IRAS data were reprocessed to increase both the number of recognized asteroid observations and their reliability. As input 7311 asteroids were used with known orbital elements as of December 1990. This processor is referred to as the IRAS Minor Planet Survey (IMPS). As of April 1991 approximately 3000 asteroids had been identified with one or more acceptable observations. These results were used to derive the total number of asteroids with diameters greater than 1 km. In addition to being an interesting piece of information in itself these size-frequency distributions produce bias-correction factors which, for example, will be used in investigations of the physical properties of asteroid dynamical families and to estimate the distribution of the taxonomic classes as a function of heliocentric distance. Author

N91-26010*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PRE-ENCOUNTER OBSERVATIONS OF 951 GASPRA Abstract Only
D. J. Tholen, J. D. Goldader, D. P. Cruikshank, and W. K. Hartmann (Planetary Science Inst., Tucson, AZ.) *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 220 (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03B

Photometry and colorimetry of 951 Gaspra were obtained on nine nights during the 1990 opposition. A composite lightcurve constructed using data from eight of those nights yielded a synodic rotational period of 7.04346 +/- 0.00006 hours, a mean absolute V magnitude of 11.8026 +/- 0.0025, and a slope parameter of 0.285 +/- 0.005. The apparent discrepancy can be easily resolved by realizing that their determination is based primarily on data obtained after opposition. Different phase functions pre- and post-opposition are a natural consequence of a changing aspect during an opposition. If the sub-Earth latitude on Gaspra is at a less equatorial aspect after opposition than it was before opposition, then we would expect to see a shallower phase function (corresponding to a larger numerical value of the slope parameter). Adding weight to this hypothesis is the last observation of the opposition, made in May after Gaspra had passed post opposition quadrature, which is displaced toward brighter absolute magnitudes relative to the rest of our data, indicating an even more poleward sub-Earth latitude than earlier in the opposition. Because the orbits of Earth and Gaspra are nearly coplanar, a substantial change in sub-Earth latitude during the opposition would not have been possible unless the obliquity of the asteroid's rotational axis is not small. Author

N91-26011*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
IRAS ASTEROID FAMILIES Abstract Only
G. J. Veeder, J. G. Williams, E. F. Tedesco, and D. L. Matson *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 225 Sponsored in part by AFGL (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03B

The Infrared Astronomical Satellite (IRAS) sampled the entire asteroid population at wavelengths from 12 to 100 microns during its 1983 all sky survey. The IRAS Minor Planet Survey (IMPS) includes updated results for more recently numbered as well as other additional asteroids with reliable orbital elements. Albedos and diameters were derived from the observed thermal emission and assumed absolute visual magnitudes and then entered into the IMPS database at the Infrared Processing and Analysis Center (IPAC) for members of the Themis, Eos, Koronis and Maria asteroid families and compared with their visual colors. The IMPS results for the small (down to about 20 km) asteroids within these major families confirm trends previously noted for their larger members. Each of these dynamical families which are defined by their similar proper elements appears to have homogeneous physical properties. Author

N91-26012*# Space Telescope Science Inst., Baltimore, MD.
INNER COMA IMAGING OF COMET LEVY (1990c) WITH THE HUBBLE SPACE TELESCOPE Abstract Only **c89**
Harold A. Weaver, Michael F. AHearn, W. A. Baum, P. D. Feldman, J. C. Brandt, J. A. Westphal, C. Arpigny, and R. M. Light (California Univ., Santa Cruz.) *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 232 (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03A

Observations of comet Levy were carried out with the Hubble Space Telescope (HST) on UT 27 Sep. 1990. The comet was imaged with the Wide Field Camera (WFC) through both red and blue filters, which were selected to isolate continuum emission peaking sharply at the nucleus. The longest exposures (4 sec) through the red filter had sufficient signal to noise that image deconvolution could be used to recover virtually the full spatial resolution of HST. These images reveal a fan-shaped inner coma in which the sunward-facing hemisphere is significantly brighter than the tailward hemisphere, consistent with volatile sublimation occurring primarily on the dayside of the nucleus. Author

N91-26013*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
LIMIT ON THE CH4/CO RATIO IN COMET LEVY (1990c) AND COMPARISONS WITH OTHER COMETS Abstract Only
Harold A. Weaver, G. Chin, T. Y. Brooke, A. T. Tokunaga, and T. R. Geballe (Joint Astronomy Centre, Hilo, HI.) *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 233 (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03B

Near-infrared observations of comet Levy (1900c) were made on UT 4.3 and 5.3 Sep. 1990 from the United Kingdom Infrared Telescope on Mauna Kea. A scanning Fabry-Perot interferometer in combination with a cooled grating spectrometer was used to make a sensitive search for fluorescent emission from the v zub 3 band of CH4 near lambda approx. 3.3 microns. If CH4 is a parent molecule released directly from the nucleus, then the 3 sigma limit on its abundance is CH4/H2O approx. less than 0.0031, assuming that the kinetic temperature of the inner coma is approx. 50 K and that the CH4 spin species are equilibrated at a temperature approx. greater than 50 K. Since International Ultraviolet Explorer (IUE) observations of CO in Levy indicate that CO/H2O approx. 0.04 (Feldman et al.), researchers find that CH4/CO approx. less than 0.1. Infrared spectroscopic searches for CH4 in Comet Halley also yielded no positive detections; the more sensitive upper limit from the latter observations is CH4/H2O approx. less than 0.002. Since CO/H2O approx. 0.05 in Halley (not including the extended source of CO), the upper limits on the CH4/CO ratios are almost identical for comets Levy and Halley. A marginal infrared detection of the CH4 v sub 3 band in comet Wilson yielded CH4/H2O approx. 0.01 to 0.05 (Larson et al.), but there was no positive detection of CO. If the identification of the feature in the infrared spectrum of comet Wilson is correct, then that would indicate a very high CH4/CO ratio in this comet.
Author

N91-26014*# Arizona State Univ., Tempe.
SPECTRA OF COMET P/HALLEY AT R = 4 - 8 AU Abstract Only
Peter A. Wehinger, Marvin Kleine, Susan Wyckoff, Stephen C. Tegler, and Michael S. J. Belton (Kitt Peak National Observatory, Tucson, AZ.) *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 234 (For primary document see N91-25982 17-90) (Grant NAGw-547)
Avail: NTIS HC/MF A13 CSCL 03B

Spectra of Comet Halley (lambda lambda = 3400-6500 A) were acquired at pre- and post-perihelion distances of 4.8 AU on 1985 Feb. 17 (Coma V equals 18.9 mag) and 1987 Feb. 1 (coma V = 15.9 mag) using the 4.5-m Multiple-Mirror Telescope (MMT) and the CTIO 4.0-m telescope, respectively. The CN(0,0) violet system band flux at 4.8 AU was approx. 15 times greater at the

post-perhelion phase compared to pre-perihelion. Additional post-perihelion spectra, obtained on 1986 Nov. 28 to 30 with the MTT, showed CN(0,0) and very weak C3 4040 A emission. The MMT data are one-dimensional spectra (aperture: 5 arc sec diameter) obtained with an intensified Reticon while the CTIO data are two-dimensional spectra (slit length = 280 arc sec) obtained with a 2D-Frutti photon counting system. Extended CN(0,0) emission was detected in the 1987 Feb. 1 (at 4.8 AU) spectra to a distance of at least 70 arc sec in the solar and anti-solar directions. Additional CCD spectra obtained with the KPNO 2.2-meter telescope on 1988 Feb. 20 (at 7.9 AU) show scattered solar continuum approx. 32 arc sec diameter. However, no emission features were detected at 7.9 AU. Author

N91-26015*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
THE COMET RENDEZVOUS ASTEROID FLYBY MISSION: A STATUS REPORT Abstract Only
Paul R. Weissman and Marcia Neugebauer *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 235 (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03B

The Comet Rendezvous Asteroid Flyby (CRAF) mission received a new start in fiscal year 1990. CRAF will match orbits with an active short-period comet and follow it around the Sun, making scientific measurements of the nucleus, coma, and tail. The Imaging system will map the nucleus surface at a resolution of 1 meter/line-pair or better, while Visible and Infrared Mapping Spectrometer (VIMS) and Thermal Infrared Radiometer Experiment (TIREX) will produce spectral and thermal maps of the surface. Onboard instruments will collect cometary dust, ice, and gases and perform elemental and molecular analysis. A suite of fields and particles instruments will observe the solar wind interaction with the cometary atmosphere and tail. Radio tracking of the spacecraft will provide an accurate measure of the nucleus mass and higher harmonics in the comet's gravity field. En route to the comet, the spacecraft will make a close flyby of a large asteroid, preferably a primitive type from the outer main belt. Observations at the asteroid include remote sensing mapping of the surface, detection of any solar wind interaction observable at the flyby distance, and measurement of the asteroid mass to better than 10 percent accuracy. Detailed design of the CRAF spacecraft is currently underway at the Jet Propulsion Laboratory (JPL). Recent mass growth has necessitated a switch to Venus-Earth gravity assist type trajectories, similar to that used by the Galileo spacecraft. These trajectories require longer flight times from launch to rendezvous with the target comet. The details of the current baseline mission, spacecraft design, and instrument payload will be reviewed. Author

N91-26016*# Smithsonian Astrophysical Observatory, Cambridge, MA.
A NEW ACTIVITY INDEX FOR COMETS Abstract Only
Fred L. Whipple *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 237 (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03B

An activity index (AI) is derived from observational data to measure the increase of activity in magnitudes for comets when brightest near perihelion as compared to their inactive reflective brightnesses at great solar distances. In all, AI determinations are made for 32 long-period (L-P) comets and for 14 short-period (S-P). The range of values of AI is the order of 3 to 10 magnitudes with a median about 6. An expected strong correlation with perihelion distance, q, was found to vary as approx. q(-2.3). Residuals from a least-square solution, delta AI, were used for comparing comets of different orbital classes, the standard deviation of a single value of delta AI was only plus or minus 1(m).1 for L-P comets and plus or minus 1(m)2 for S-P comets. Among the L-P comets, 19 of Period, P greater than 10(exp 4) yr yielded delta AI greater than or equal to -0(m).27 compared to +0(m).39 for 13 of 10(exp 4) greater than P greater than 10(exp 2) yr. This denies any effect of aging among the L-P comets. The 14 S-P comets yielded (delta AI) less 0(m).3 plus or minus 0(m).3 than the 32 L-P comets. The results suggest a common actively level, nature and probably origin for comets of all orbits, sizes and ages. Author

N91-26017*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PLANETOLOGICAL IMPLICATIONS OF MASS LOSS FROM THE EARLY SUN Abstract Only **c91**
D. P. Whitmire, J. J. Matese (University of Southwestern Louisiana, Lafayette.), L. R. Doyle, and R. T. Reynolds *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 238 (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03B

The element lithium is observed to be underabundant in the Sun by a factor of approx. equal to 100. To account for this depletion, Boothroyd et al. (Ap. J., in press 1991) proposed a model in which the Sun's zero-age-main-sequence mass was approx. 1.1 solar magnitude. If this is the explanation for the lithium depletion, then astronomical observations of F/G dwarfs in clusters suggest that the timescale for mass loss is approx. equal to 0.6 Gyr. Assuming this approximate timescale, the authors investigated several planetological implications of the astrophysical model. Author

N91-26018*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
THE EFFECT OF ELECTRON COLLISIONS ON ROTATIONAL EXCITATION OF COMETARY WATER Abstract Only
Xingfa Xie (Pennsylvania Univ., Philadelphia.) and Michael J. Mumma *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 246 (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03B

The e-H2O collisional rate for exciting rotational transitions in cometary water is evaluated for conditions found in Comet Halley. The e-H2O collisional rate exceeds that for excitation by neutral-neutral collisions at distances exceeding 3000 km from the cometary nucleus, in the case of the O sub 00 yields 1 sub 11 transition. The estimates are based on theoretical and experimental studies of e-H2O collisions, on ion and electron parameters acquired in-situ by instruments on the Giotto and Vega spacecraft, and on results obtained from models of the cometary ionosphere. The contribution of electron collisions may explain the need for large water-water cross-sections in models which neglect the effect of electrons. The importance of electron collisions is enhanced for populations of water molecules in regions where their rotational lines are optically thick. Author

N91-25210*# Arizona Univ., Tucson. Dept. of Geosciences.
ABUNDANCES OF VOLATILE-BEARING PHASES IN CARBONACEOUS CHONDRITES AND COOLING RATES OF METEORITES BASED ON CATION ORDERING OF ORTHOPYROXENES
Jibamitra Ganguly *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 5 p (For primary document see N91-25203 17-25)
Avail: NTIS HC/MF A08 CSCL 03B

N91-25220*# Planetary Science Inst., Tucson, AZ.
PRELIMINARY ANALYSIS OF SURFACE CHARACTERISTICS OF COMET TEMPEL 2 Abstract Only
H. Campins *In* Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 1 p (For primary document see N91-25203 17-25)
Avail: NTIS HC/MF A08 CSCL 03B

N91-25221*# Arizona Univ., Tucson. Lunar and Planetary Lab.
NOTES ON LUNAR ILMENITE
M. L. Hutson *In its* NASA Space Engineering Research Center

for Utilization of Local Planetary Resources 1989 6 p (For primary document see N91-25203 17-25)
Avail: NTIS HC/MF A08 CSCL 03B

N91-25222*# Arizona Univ., Tucson. Dept. of Geosciences.
THEORETICAL PREDICTIONS OF VOLATILE BEARING PHASES AND VOLATILE RESOURCES IN SOME CARBONACEOUS CHONDRITES
Jibamitra Ganguly and Surendra K. Saxena (City Univ. of New York, Brooklyn.) *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 9 p (For primary document see N91-25203 17-25)
Avail: NTIS HC/MF A08 CSCL 03B

N91-25240*# Arizona Univ., Tucson. Lunar and Planetary Lab.
SEARCH FOR NEAR-EARTH ASTEROIDS WITH THE SPACEWATCH CAMERA
T. Gehrels *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 2 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 03B

N91-25242*# Arizona Univ., Tucson. Lunar and Planetary Lab.
COMPOSITIONS OF NEAR-EARTH ASTEROIDS
Larry A. Lebofsky and Marcia L. Nelson *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 4 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 03B

N91-25246*# Arizona Univ., Tucson. Planetary Sciences Inst.
DATA BASE ON PHYSICAL OBSERVATIONS OF NEAR-EARTH ASTEROIDS AND ESTABLISHMENT OF A NETWORK TO COORDINATE OBSERVATIONS OF NEWLY DISCOVERED NEAR-EARTH ASTEROIDS
D. R. Davis, C. R. Chapman, and H. Campins *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 2 p (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 03B

N91-25247*# BDM International, Inc., Albuquerque, NM.
ENGINEERING, CONSTRUCTION, AND OPERATIONS IN SPACE
Stewart W. Johnson, ed. and John P. Wetzel, ed. *In* Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources New York, NY American Society of Civil Engineers 1990 18 p Proceedings held in Albuquerque, NM, 29-31 Aug. 1988; sponsored in part by NASA, Johnson Space Center, ASCE, AIAA, Society of American Military Engineering, Space Studies Inst., AF, Army Prepared in cooperation with Bechtel International Corp., San Francisco, CA, and Lovelace Scientific Resources, Inc., Albuquerque, NM (For primary document see N91-25223 17-25)
Avail: NTIS HC/MF A13; 5 functional color pages CSCL 03B

N91-25917*# Southwestern Adventist Coll., Keene, TX. Dept. of Physics.
MONTE CARLO SIMULATION OF PARTICLE ACCELERATION AT ASTROPHYSICAL SHOCKS Abstract Only
Roy K. Campbell *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 13 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 03B

N91-26041*# Arizona Univ., Tucson. Lunar and Planetary Lab.
NEAR-INFRARED OBSERVATIONS OF PRIMITIVE ASTEROIDS AND A POSSIBLE EXTINCT COMET Abstract Only
E. S. Howell and Larry A. Lebofsky *In its* Resources of Near-Earth Space: Abstracts 1991 p 15 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

N91-26042*# Arizona Univ., Tucson. Lunar and Planetary Lab.
CHARACTERIZATION OF LOW ALBEDO ASTEROIDS Abstract Only
Larry A. Lebofsky and Marcia L. Nelson *In its* Resources of Near-Earth Space: Abstracts 1991 p 15 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

N91-26054*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
AN ISU STUDY OF ASTEROID MINING Abstract Only
J. D. Burke *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 20 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

N91-26056*# Arizona Univ., Tucson. Lunar and Planetary Lab.
ENSTATITE CHONDRITES AND ACHONDRITES AS ASTEROIDAL RESOURCES Abstract Only
M. L. Hutson and John S. Lewis *In its* Resources of Near-Earth Space: Abstracts 1991 p 21 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

N91-26057*# Jet Propulsion Lab., California Inst. of Tech., Pasadena. Earth and Space Sciences Div.
SHORT-PERIOD COMETS Abstract Only
Paul R. Weissman and Humberto Campins (Florida Univ., Gainesville.) *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 22 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

N91-26058*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NEAR-EARTH ASTEROIDS: METALS OCCURRENCE, EXTRACTION, AND FABRICATION Abstract Only
Richard Westfall *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 22 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

N91-26059*# Analex Corp., Cleveland, OH.
MOMENTUM HARVESTING TECHNIQUES FOR SOLAR SYSTEM TRAVEL Abstract Only
Alan J. Willoughby *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 23 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

N91-26061*# Brown Univ., Providence, RI. Dept. of Geological Sciences.
THE COMPOSITION OF PHOBOS: METEORITE ANALOGS BASED ON KRFM AND VSK SPECTRAL DATA FROM THE PHOBOS 2 SPACECRAFT Abstract Only
D. T. Britt and S. L. Murchie *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 24 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

N91-26070*# State Univ. of New York, Plattsburgh. Dept. of Physics.
THE METEORITIC CONTRIBUTION TO THE REGOLITHS OF MARS, DEIMOS, AND PHOBOS Abstract Only
G. J. Flynn *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 29 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

N91-26089*# Academy of Sciences (USSR), Leningrad. Fiziko-Tekhnicheskij Inst.
OUTER PLANETS AND ICY SATELLITES Abstract Only
E. M. Drobyshevski *In* Arizona Univ., Resources of Near-Earth

Space: Abstracts 1991 p 37 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

N91-26092*# Mitre Corp., Bedford, MA.
ACCESSIBILITY OF NEAR-EARTH ASTEROIDS, 1990 Abstract Only
Neal D. Hulkower and Jack B. Child (World Space Foundation, Pasadena, CA.) *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 38 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

N91-26094*# Harvard-Smithsonian Center for Astrophysics, Cambridge, MA.
AN OBSERVATIONAL INVESTIGATION OF THE COMET-ASTEROID CONNECTION Abstract Only
Jane X. Luu *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 39 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

N91-26095*# Shemakha Astrophysical Observatory, Azerbaijan (USSR).
NEAR-EARTH AND NEAR-MARS ASTEROIDS: PROGNOSIS OF PYROXENE TYPES Abstract Only
D. I. Shestopalov and L. F. Golubeva *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 40 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

91 LUNAR AND PLANETARY EXPLORATION

Includes planetology; and manned and unmanned flights. For spacecraft design or space stations see *18 Spacecraft Design, Testing and Performance.*

N91-26019*# Arizona Univ., Tucson. NASA Space Engineering Research Center.
RESOURCES OF NEAR-EARTH SPACE: ABSTRACTS Abstracts Only
1991 52 p The 2nd Annual Symposium of the Univ. of Arizona/NASA Space Engineering Research Center for Utilization of Local Planetary Resources, Tucson, AZ, 7-10 Jan. 1991
(NASA-CR-188219; NAS 1.26:188219) Avail: NTIS HC/MF A04 CSCL 03B

The objectives are by theory, experiment, and bench-level testing of small systems, to develop scientifically-sound engineering processes and facility specifications for producing propellants and fuels, construction and shielding materials, and life support substances from the lithospheres and atmospheres of lunar, planetary, and asteroidal bodies. Current emphasis is on the production of oxygen, other useful gases, metallic, ceramic/composite, and related byproducts from lunar regolith, carbonaceous chrondritic asteroids, and the carbon dioxide rich Martian atmosphere. For individual titles, see N91-26020 through N91-26097.

N91-26020*# Space Data Resources and Information, Washington, DC.
UTILIZATION OF SPACE RESOURCES: A HISTORICAL VIEW Abstract Only
Leonard W. David *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 6 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

While widely accepted today, the use of non-Earth resources in official space planning circles has been long in coming. Popular and governmental acceptance of using extraterrestrial resources, be they asteroids, comets, or other celestial bodies are highlighted. Particular emphasis is placed on those individuals, such as the late Dandridge Cole, who pioneered early discussion and thought on the topic over a period of several decades. The evolution of using extraterrestrial resources in governmental space policy, such as NASA's Outlook for Space (1976) and Pioneering the Space Frontier (1986) is reviewed. Put forward is the view that a redefinition of resources of near-Earth space may be warranted, particularly in consideration of using high vacuum, solar radiation, and magnetospheric phenomenon for experimentation and application purposes. Lastly, a prospective look at public reaction to utilizing space resources is presented. Author

N91-26021*# Worcester Polytechnic Inst., MA. Dept. of Chemical Engineering.
MECHANISMS OF ILMENITE REDUCTION AND THEIR IMPACT ON THE DESIGN OF EFFECTIVE REACTOR SYSTEMS Abstract Only
R. A. Briggs and A. Sacco *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 6 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

One of the first activities at a lunar base could be oxygen recovery from ilmenite (FeTiO3). Oxygen produced from lunar soils could be used to fuel transportation vehicles operating in near-earth space. The first step in developing a suitable reactor system for lunar operation is to determine the mechanisms and rates of oxygen removal from ilmenite. In-situ gravimetric measurements and microscopic examinations were used to determine the hydrogen reduction mechanisms of synthetic ilmenite discs between 823 to 1353 K. A shrinking core reaction model, modified to account for the growth of an iron film on the surface of discs, was capable of predicting experimentally observed conversion-time relationships. The observed reduction mechanism, kinetic rates, and associated activation energy established a base line from which comparisons could be made to improve oxygen yield and removal rates. One proposed technique to improve the rate and extent of oxygen removal was to preoxidize ilmenite. Preoxidation is commonly used during the reduction of ilmenite ores in the iron industry and has been employed for many years to lower operating temperatures and increase reduction rates. This technology could prove beneficial for oxygen production facilities on the Moon as less massive reactor vessels and/or less energy could be associated with a process including preoxidation. X ray diffraction and energy dispersive spectroscopy were utilized to follow the progression of ilmenite oxidation at 1123 and 1140 K and the reduction of pseudobrookite (Fe_2TiO_5) at 873 and 973 K. Structures formed during the progress of oxidation were related to the system's phase diagrams. Results indicated that after initially producing ilmenite-hematite solutions and rutile (TiO_2), pseudobrookite was the end product of oxidation at all temperatures examined (1049 to 1273 K). Initial results from the reduction of pseudobrookite indicate a series of phases are produced including ferropseudobrookite ($FeTi_2O_5$), ulvospinel (Fe_2TiO_4), and ilmenite. Rates of pseudobrookite reduction were typically 50 to 200 times that of ilmenite. Author

N91-26022*# Bureau of Mines, Minneapolis, MN.
MINING AND BENEFICIATION: A REVIEW OF POSSIBLE LUNAR APPLICATIONS Abstract Only
Peter G. Chamberlain *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 7 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Successful exploration of Mars and outer space may require base stations strategically located on the Moon. Such bases must develop a certain self-sufficiency, particularly in the critical life support materials, fuel components, and construction materials. Technology is reviewed for the first steps in lunar resource recovery-mining and beneficiation. The topic is covered in three main categories: site selection; mining; and beneficiation. It will also include (in less detail) in-situ processes. The text described mining technology ranging from simple diggings and hauling vehicles (the strawman) to more specialized technology including underground excavation methods. The section of beneficiation emphasizes dry separation techniques and methods of sorting the

ore by particle size. In-situ processes, chemical and thermal, are identified to stimulate further thinking by future researchers.
Author

N91-26023*# Washington Univ., Saint Louis, MO. Dept. of Earth and Planetary Sciences.
ELECTROLYSIS OF LUNAR SOIL TO PRODUCE OXYGEN AND METALS Abstract Only
Russell O. Colson, Larry A. Haskin, and R. Keller *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 7 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

The discussion of melt electrolysis consists of three sections. The implications of the chemistry and physics of fluxed and raw melts on melt electrolysis are discussed first. This includes discussion of the factor that influence melt resistivity, melt viscosity, oxygen production efficiency, and the theoretical energy required to produce oxygen. Second, the implications of phase equilibria and solubilities in silicate melts on the selection of materials for container and electrodes are discussed. The implications of proposed container and electrode materials on melt composition and how this effects expected resistivities, viscosities, as outlined in the first section are discussed. Finally, a general discussion of the basic features of both the fluxed and unfluxed melt electrolysis is given, including their advantages and disadvantages and how they compare with alternative processes. Author

N91-26024*# Washington Univ., Saint Louis, MO. Dept. of Earth and Planetary Sciences.
MAGMA ELECTROLYSIS: AN UPDATE Abstract Only
Russell O. Colson and Larry A. Haskin *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 7 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Electrolytic extraction of O2 from molten lunar soil is conceptually simple and thus a candidate process for producing O2 on the Moon. Possible container and electrode materials are being tested for durability in corrosive high-temperature silicate melts and looking for complications that might increase energy requirements. Gaseous oxygen is being produced by electrolysis of 1-2 gram quantities of silicate melts in spinel ($MgAl_2O_4$) crucibles; in these melts, spinel is a stable phase. The concentration of FeO was kept low because FeO decrease O2 production efficiency. Platinum electrodes were placed about 0.5 cm apart in the melt. The spinel crucible was still intact after 40 minutes of electrolysis, when the experiment was halted for examination. The Pt anode was also intact; its Pt was maintained in a dynamci state in which the anode was continuously oxidized but quickly reduced again by the silicate melt, inhibiting migration of Pt away from the anode. In melts with low concentrations of Al_2O_3 + SiO2 (2 wt percent), the energy of resistance heating was only approximately equal to 10 to 20 percent of the theoretical amount required to produce O2. In melts substantially more concentrated in Al_2O_3 + SiO2, higher melt viscosity resulted in frothing that, in the worst case, caused high enough melt resistivities to raise the energy requirements to nearly 10 times theoretical. Both Fe and Si are produced at the cathode; in iron-rich melts, a- and c-iron and molten ferrosilicon were observed. Production was also observed at the cathode of a previously unrecognized gas; which is not yet identified. The solubility of metallic species was measured in silicate melts. They are too low to reduce significantly the efficiency of O2 production. Author

N91-26025*# Arizona Univ., Tucson. Dept. of Materials Science and Engineering.
REFRACTORY MATERIALS FROM LUNAR RESOURCES Abstract Only
B. D. Fabes and W. H. Poisl *In its* Resources of Near-Earth Space: Abstracts 1991 p 8 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Refractories - materials which are able to withstand extremely high temperatures - are sure to be an important part of any processing facility or human outpost which is built on Mars. Containers for processing lunar oxygen will need high temperature components. Fabrication of structural material from lunar resources need both containment vessels to hold high temperature melts and molds in which to form the final shapes. Certainly, it would be desirable to fabricate such vessels and molds on the Moon, rather than carrying them up from the Earth. At first glance, this might appear to be a trivial task, since the Moon's surface consists of a variety of refractory compositions. To turn the regolith into a useful fire brick or mold, however, will require water or other binders and additives which are likely to be in extremely short supply on the Moon. The steps needed to make fire bricks and molds for lunar-derived structural materials are examined, pointing out the critical steps and resources which will be needed. While these processes and applications may seem somewhat mundane, it is emphasized that it is precisely these rudimentary processes which must be mastered before discussing making aerobrakes, and other fancier refractories from lunar resources. Author

N91-26026*# Nevada Univ., Reno. Dept. of Geology.
POSSIBLE LUNAR ORES Abstract Only
Stephen L. Gillett *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 8 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Despite the conventional wisdom that there are no lunar ores, geochemical considerations suggest that local concentrations of useful rare elements exist on the Moon in spite of its extreme dryness. The Moon underwent protracted igneous activity in its history, and certain magmatic processes can concentrate incompatible elements even if anhydrous. Such processes include: (1) separation of a magma into immiscible liquid phases (depending on composition, these could be silicate-silicate, silicate-oxide, silicate-sulfide, or silicate-salt); (2) cumulate deposits in layered igneous intrusions; and (3) concentrations of rare, refractory, lithophile elements (e.g., Be, Li, Zr) in highly differentiated, silica-rich magmas, as in the lunar granites. Terrestrial mining experience indicates that the single most important characteristic of a potential ore is its concentration of the desire element. The utility of a planet as a resource base is that the welter of interacting processes over geologic time can concentrate rare element automatically. This advantage is squandered if adequate exploration for ores is not first carried out. Author

N91-26027*# Washington Univ., Saint Louis, MO. Dept. of Earth and Planetary Sciences.
A GEOCHEMICAL ASSESSMENT OF POSSIBLE LUNAR ORE FORMATION Abstract Only
Larry A. Haskin, Russell O. Colson, and David Vaniman (Los Alamos National Lab., NM.) *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 9 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

The Moon apparently formed without appreciable water or other relatively volatile materials. Interior concentrations of water or other volatile substances appear to be extremely low. On Earth, water is important to the genesis of nearly all types of ores. Thus, some have reasoned that only abundant elements would occur in ore concentrations. The definition and recognition of ores on the Moon challenge the imaginations and the terrestrial perceptions of ore bodies. Lunar ores included solar-wind soaked soils, which contain abundant but dilute H, C, N, and noble gases (including He-3). Oxygen must be mined; soils contain approximately 45 percent (wt). Mainstream processes of rock formation concentrated Si, Mg, Al, Fe, and Ca, and possibly Ti and Cr. The highland surface contains approximately 70 percent (wt) feldspar (mainly $CaAl_2Si_2O_8$), which can be separated from some highland soils. Small fragments of dunite were collected; dunite may occur in walls and central peaks of some craters. Theoretical extensions of observations of lunar samples suggest that the Moon may have produced ores of trace elements. Some small fragments have trace-element concentrations 10(exp 4) times higher than the lunar average, indicating that effective geochemical separations

occurred; processes included fractional crystallization, silicate immiscibility, vaporization and condensation, and sulfide metamorphism. Operations of these processes acting on indigenous materials and on meteoritic material in the regolith could have produced ores. Infalling carbonaceous meteorites and comets have added water and hydrocarbons that may have been cold-trapped. Vesicles in basalts, pyroclastic beads, and reported transient events suggest gag emission from the lunar interior; such gas might concentrate and transport rare elements. Large impacts may disperse ores or produce them through deposition of heat at depth and by vaporization and subsequent condensation. The main problem in assessing lunar resources is the ignorance about the largely unexplored Moon. Author

N91-26028*# Washington Univ., Saint Louis, MO. Dept. of Earth and Planetary Sciences.
ON PREDICTION AND DISCOVERY OF LUNAR ORES Abstract Only
Larry A. Haskin, Russell O. Colson, and David Vaniman *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 9 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Sampling of lunar material and remote geochemical, mineralogical, and photogeologic sensing of the lunar surface, while meager, provide first-cut information about lunar composition and geochemical separation processes. Knowledge of elemental abundances in known lunar materials indicates which common lunar materials might serve as ores if there is economic demand and if economical extraction processes can be developed, remote sensing can be used to extend the understanding of the Moon's major geochemical separations and to locate potential ore bodies. Observed geochemical processes might lead to ores of less abundant elements under extreme local conditions. Author

N91-26029*# Arizona Univ., Tucson. Planetary Image Research Lab.
REMOTE COMPOSITIONAL MAPPING OF LUNAR TITANIUM AND SURFACE MATURITY Abstract Only
J. R. Johnson, S. M. Larson, and Robert B. Singer *In its* Resources of Near-Earth Space: Abstracts 1991 p 10 (For primary document see N91-26019 17-91)
(Grants NAGw-247; NAGw-1332)
Avail: NTIS HC/MF A04 CSCL 03B

Lunar ilmenite (FeTiO3) is a potential resource capable of providing oxygen for life support and spacecraft propellant for future lunar bases. Estimates of TiO2 content in mature mare soils can be made using an empirical relation between the 400/500 nm reflectance ratio and TiO2 wt percent. A TiO2 abundance map was constructed for the entire near-side lunar maria accurate to + or - 2 wt percent TiO2 using CCD images obtained at the Tumamoc Hill 0.5 m telescope in Tucson, employing bandpass filters centered at 400 and 560 nm. Highest TiO2 regions in the maria are located in western Mare Tranquillitatis. Greater contrast differences between regions on the lunar surface can be obtained using 400/730 nm ratio images. The relation might well be refined to accommodate this possibly more sensitive indicator of TiO2 content. Another potential lunar resource is solar wind-implanted He-3 which may be used as a fuel for fusion reactors. Relative soil maturity, as determined by agglutinate content, can be estimated from 950/560 nm ration images. Immature soils appear darker in this ratio since such soils contain abundant pyroxene grains which cause strong absorption centered near 950 nm due Fe(2+) crystal field transitions. A positive correlation exists between the amount of He-3 and TiO2 content in lunar soils, suggesting that regions high in TiO2 should also be high in He-3. Reflectance spectrophotometry in the region 320 to 870 nm was also obtained for several regions. Below about 340 nm, these spectra show variations in relative reflectance that are caused by as yet unassigned near-UV absorptions due to compositional differences. Author

N91-26030*# Michigan Technological Univ., Houghton.
UTILIZATION OF LUNAR ILMENITE: BASALT OR REGOLITH? Abstract Only
S. K. Kawatra and K. L. DeLaO *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 10 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

A critical discussion of whether lunar basalt or regolith should be used as a resource for mineral processing schemes on the lunar surface, with pros and cons for each argument is presented. A literature review has shown that the majority of authors feel that mining the lunar basalt, crushing it, and then processing to remove the desired minerals, would be the route to take. The argument that this method would not be a sound mineral processing practice is presented. Mining and crushing are difficult propositions even on Earth; to attempt such processes in the hostile lunar environment would be a phenomenal task. It would be better to start with a simpler scheme, such as processing the regolith, which can be adapted to the multitude of unknowns facing the first lunar production plant. If, however, the lunar mining trend is followed, it must be kept in mind that mining and processing technology which is radically different from what is currently available and used on Earth will have to be developed. Podnieks and Roepke (1987) and Lindroth and Podnieks (1987) have summarized the new technology that may be applicable, but this technology is very similar to the current, 99 percent inefficient technology used on Earth. One such possible technique is sodium vapor fragmentation of basalt. Initial testwork was conducted at Michigan Technological University on terrestrial basalt with extremely promising results, though much time and effort will be needed to fully develop this process. Author

N91-26031*# Kuck (David L.), Oracle, AZ.
EXTRATERRESTRIAL RESOURCES: IMPLICATIONS FROM TERRESTRIAL EXPERIENCE Abstract Only
David L. Kuck and Stephen L. Gillett (Nevada Univ., Reno.) *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 11 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Terrestrial mining experience indicates that the overwhelming criterion of a potentially economic deposit is its recoverable concentration of the desired mineral or element. Recovery can be based on contrast in physical and/or chemical properties, but processes based on physical properties are typically less expensive. As several processes generally are used in sequence, they have a profound effect on extraction costs. These criteria will also apply to extraterrestrial resources. Although the extreme cost of access to space makes even ordinary materials extremely valuable, this inaccessibility also makes capital and maintenance costs extremely high. The following four development stages will apply, especially with the additional unknowns of an extraterrestrial environment: (1) Exploration for the highest grade of the mineral or element desired (because the extraction plant must be simple, cheap, and rugged to minimize capital and maintenance costs, high grade is extremely important); (2) Laboratory testing of various physical and/or chemical separation techniques on the possible ore to determine if the material can indeed be recovered economically; (3) a pilot plant test, in which a large sample is dug from the deposit to determine excavation rates, power requirements, and equipment wear. (This sample is then run through a pilot mill designed on the basis of the laboratory testing. Pilot plant testing must be carried out at increasing scales, but several trials are generally necessary at each scale before the size of operations can be increased. Moreover, pilot testing is necessary for each new mineral deposit); and (4) Last is the full-scale mine and plant start-up. (New problems invariably occur at this point, but they can be kept to a minimum if the pilot plant tests were realistic). If such a development plan is followed rigorously, major cost overruns, with their potentially disastrous effects on resource developments, can be avoided. Author

N91-26032*# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.). Space Systems Analysis Div.

OXYGEN EXTRACTION FROM LUNAR SOIL BY FLUORINATION Abstract Only

W. Seboldt, S. Lingner, S. Hoernes, and W. Grimmeisen (Bonn Univ., Germany, F.R.) *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 11 (For primary document see N91-26019 17-91)

Avail: NTIS HC/MF A04 CSCL 03B

Mining and processing of lunar material could possibly lead to more cost-efficient scenarios for permanent presence of man in space and on the Moon. Production of oxygen for use as propellant seems especially important. Different candidate processes for oxygen-extraction from lunar soil were proposed, of which the reduction of ilmenite by hydrogen was studied most. This process, however, needs the concentration of ilmenite from lunar regolith to a large extent and releases oxygen only with low efficiency. Another possibility - the fluorination method - which works with lunar bulk material as feedstock is discussed. Liberation of oxygen from silicate or oxide materials by fluorination methods has been applied in geoscience since the early sixties. The fact that even at moderate temperatures 98 to 100 percent yields can be attained, suggests that fluorination of lunar regolith could be an effective way of propellant production. Lunar soil contains about 50 percent oxygen by weight which is gained nearly completely through this process as O2 gas. The second-most element Si is liberated as gaseous SiF4. It could be used for production of Si-metal and fluorine-recycling. All other main elements of lunar soil will be converted into solid fluorides which also can be used for metal-production and fluorine-recycling. Preliminary results of small scale experiments with different materials are discussed, giving information on specific oxygen-yields and amounts of by-products as functions of temperature. These experiments were performed with an already existing fluorine extraction and collection device at the University of Bonn, normally used for determination of oxygen-isotopic abundances. Optimum conditions, especially concerning energy consumption, are investigated. Extrapolation of the experimental results to large industrial-type plants on the Moon is tried and seems to be promising at first sight. The recycling of the fluorine is, however, crucial for the process. It might be achieved by means of electrolysis. This needs further investigation. The technical problem of transport and handling of the toxic and corrosive fluorine seems to be solvable and could be done by inert storage vessels. Author

N91-26033*# PSI Technology Co., Andover, MA.

OXYGEN PRODUCTION BY PYROLYSIS OF LUNAR REGOLITH Abstract Only

Constance L. Senior *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 12 (For primary document see N91-26019 17-91)

Avail: NTIS HC/MF A04 CSCL 03B

Oxygen was identified as the most important product of initial lunar materials processing efforts. A source of oxygen on the Moon provides an alternative to the costly transport of propellant to the Moon or to low earth orbit. Pyrolysis, or vapor-phase reduction, involves heating a feedstock to temperatures sufficient to decompose the constituent metal oxides and release oxygen. The process relies on the vaporization of metal oxides in the form of reduced suboxides or atomic species. The reduced species must then be condensed without re-oxidizing, yielding oxygen in the gas phase. The feasibility of obtaining oxygen from common lunar minerals was demonstrated using solar furnace experiments. These results are discussed together with chemical equilibrium models which were extended to include the multicomponent oxides used in experiments. For the first time, both experiments and theoretical models dealt with the complex oxides that make up potential lunar feedstocks. Two major conclusions are drawn from this preliminary work. First, unbeneficiated regolith is a suitable feedstock for pyrolysis. Second, the process can operate at moderate temperatures, circa 2000 K, which could be supplied by direct solar or electrical energy. In addition to these advantages in choice of feedstock and energy source, the pyrolysis process requires no chemicals or reagents, making it an attractive process for lunar oxygen production. Author

N91-26034*# Tennessee Univ., Knoxville. Dept. of Geological Sciences.

OXYGEN PRODUCTION PROCESSES ON THE MOON: AN OVERVIEW Abstract Only

Lawrence A. Taylor and W. David Carrier, III (Bromwell and Carrier, Inc., Lakeland, FL.) *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 12 (For primary document see N91-26019 17-91)

Avail: NTIS HC/MF A04 CSCL 03B

The production of oxygen on the Moon utilizing indigenous material is paramount to a successful lunar colonization. Several processes were put forth to accomplish this. The lunar liquid oxygen (LLOX) generation schemes which have received the most study to date are those involving: (1) the reduction of ilmenite (FeTiO3) by H2, C, CO, CH4, CO-Cl2 plasma; (2) magma electrolysis, both unadulterated and fluoride-fluxed, and (3) several others, including carbo-chlorination, HF acid leaching, fluorine extraction, magma oxidation, and vapor pyrolysis. The H2 reduction of ilmenite and magma electrolysis processes have received the most study to date. At this stage of development, they both appear feasible schemes with various pros and cons. However, all processes should be addressed at least at the onset of the considerations. It is ultimatley the energy requirements of the entire process, including the acquisition of feedstock, which will determine the mode of oxygen productions. There is an obvious need for considerably more experimentation and study. Some of these requisite studies are in progress, and several of the most studied and feasible processes for winning oxygen from lunar materials are reviewed. Author

N91-26035*# Arizona Univ., Tucson. Dept. of Chemical Engineering.

REACTION ENGINEERING FOR MATERIALS PROCESSING IN SPACE: REDUCTION OF ILMENITE BY HYDROGEN AND CARBON MONOXIDE Abstract Only

Y. Zhao and F. Shadman *In its* Resources of Near-Earth Space: Abstracts 1991 p 12 (For primary document see N91-26019 17-91)

Avail: NTIS HC/MF A04 CSCL 03B

Oxygen is a consumable material which needs to be produced continuously in most space missions. Its use for propulsion as well as life support makes oxygen one of the largest volume chemicals to be produced in space. Production of oxygen from lunar materials is of particular interest and is very attractive possibility. The kinetics and mechanism of reduction of ilmenite by carbon monoxide and hydrogen at 800 to 1100 C were investigated. The temporal profiles of conversion for carbon monoxide have a sigmoidal shape and indicate the presence of three different stages (induction, acceleration, and deceleration) during the reduction reaction. The apparent activation energy decreases from 18 kcal/mole at 10 percent conversion to 10 kcal/mole at 50 percent conversion. The reaction is first order with respect to carbon monoxide under the experimental conditions studied. Both SEM and EDX analysis show that the diffusion of Fe product away from the reaction front and through the TiO2 phase, followed by the nucleation and growth of a separate Fe phase are important steps affecting the process kinetics. The results from hydrogen reduction show that the mechanism of ilmenite reduction by hydrogen is similar to that by carbon monoxide. However, the titanium dioxide can be further reduced by hydrogen at 800 to 1000 C. The detailed comparison and theoretical modeling of both reduction processes is presented. Author

N91-26036*# Arizona Univ., Tucson. Dept. of Geosciences.

KINETICS OF VOLATILE EXTRACTION FROM CARBONACEOUS CHONDRITES: DEHYDRATION OF TALC Abstract Only

Kunal Bose and Jibamitra Ganguly *In its* Resources of Near-Earth

Space: Abstracts 1991 p 13 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Carbonaceous chondrites are believed to be the primary constituents of near-Earth asteroids and Phobos and Deimos, and are potential resources of fuels that may be exploited for future planetary missions. Calculations of equilibrium phase relations suggest that talc (Ta) and antigorite (Ant) are likely to be the major hydrous phases in the C1 and C2 meteorites (Ganguly and Saxena, 1989), which constitute the most volatile rich classes of carbonaceous chondrites. The dehydration kinetics of talc are studied as a function of temperature, grain size, composition and fluid fugacity, as part of a systematic study of the reaction kinetics of the volatile bearing phases that are either known or likely to be present in carbonaceous chondrites. The dehydration kinetics were investigated at 1 bar, 775 to 875 C by monitoring the in-situ weight loss as a function of time of a natural talc. The talc platelets had a dimension of 0.8 to 1 micron. The run durations varied from 233.3 hours at 775 C (48 percent dehydration) to 20.8 hours at 875 C (80 pct. dehydration). The results can be adequately represented by a given rate equation. Theoretical analysis suggests that the reduction in the concentration of H2O in the environment of dehydrating talc, as would be encountered in processing chondritic materials, will have negligible effect on the rate of dehydration, unless there is a change of reaction mechanism owing to the presence of other volatile species. Author

N91-26037*# Brown Univ., Providence, RI.
THE SPECTRAL RELATIONSHIPS BETWEEN NEA AND THE METEORITES: AN OVERVIEW USING PRINCIPAL COMPONENTS ANALYSIS Abstract Only
D. T. Britt, D. J. Tholen, J. F. Bell (Hawaii Univ., Honolulu.), and C. M. Pieters *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 13 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

One of the primary reservoirs for meteorites is probably the planet-crossing Aten, Apollo, and Amor asteroids. Comparing the spectral characteristics of these two populations with each other and with the spectra of the main belt asteroids would provide insight into the dynamical processes that deliver meteorites to Earth. One method for obtaining an overview of general relationships in a large spectral data set is the statistical technique of principal components analysis. This technique quantifies general spectral similarities and reprojects the data in a plot of major axes of variation where distance is a measure of relative similarity. A major caveat should be kept in mind, however, spectra are sensitive to particle size and viewing geometry effects, and near Earth asteroids (NEA's) are probably significantly different from main belt asteroids in both these factors. The analysis was restricted to the spectral range of ECAS filters and included 116 meteorite spectra from the Gaffey (1976) survey and 417 asteroids from the Zellner et. al. (1985) survey of which 13 are planet-crossers. Although thirteen asteroids are not much of a sample on which to base conclusions, a few inferences can be drawn from this exercise. First, the NEA spectral characteristics are, on average, more consistent with the spectra of meteorites than are the main belt asteroids. Second, the S-type NEA's tend to be spectrally more similar to the ordinary chondrite meteorites than the main belt S-types. This suggests that the planet-crossing S-types do not represent the spectral range of the main belt S-type population and that the planet-crossing S-types are on average more like the ordinary chondrites than the main belt S-types. Third, the only direct asteroidal ordinary chondrite analog, the Q-type asteroid, 1862 Apollo, plots well within the field of the ordinary chondrite meteorites and represents the most common meteorite fall type. Finally, it is interesting that the planet-crossing asteroids occupy similar PCA space with the general trend of the meteorites while most of the main belt objects are offset from the meteorites in statistical space. Author

N91-26038*# Arizona Univ., Tucson.
ASTEROID/METEORITE STREAMS Abstract Only
J. Drummond *In its* Resources of Near-Earth Space: Abstracts 1991 p 14 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

The independent discovery of the same three streams (named alpha, beta, and gamma) among 139 Earth approaching asteroids and among 89 meteorite producing fireballs presents the possibility of matching specific meteorites to specific asteroids, or at least to asteroids in the same stream and, therefore, presumably of the same composition. Although perhaps of limited practical value, the three meteorites with known orbits are all ordinary chondrites. To identify, in general, the taxonomic type of the parent asteroid, however, would be of great scientific interest since these most abundant meteorite types cannot be unambiguously spectrally matched to an asteroid type. The H5 Pribram meteorite and asteroid 4486 (unclassified) are not part of a stream, but travel in fairly similar orbits. The LL5 Innisfree meteorite is orbitally similar to asteroid 1989DA (unclassified), and both are members of a fourth stream (delta) defined by five meteorite-dropping fireballs and this one asteroid. The H5 Lost City meteorite is orbitally similar to 1980AA (S type), which is a member of stream gamma defined by four asteroids and four fireballs. Another asteroid in this stream is classified as an S type, another is QU, and the fourth is unclassified. This stream suggests that ordinary chondrites should be associated with S (and/or Q) asteroids. Two of the known four V type asteroids belong to another stream, beta, defined by five asteroids and four meteorite-dropping (but unrecovered) fireballs, making it the most probable source of the eucrites. The final stream, alpha, defined by five asteroids and three fireballs is of unknown composition since no meteorites have been recovered and only one asteroid has an ambiguous classification of QRS. If this stream, or any other as yet undiscovered ones, were found to be composed of a more practical material (e.g., water or metalrich), then recovery of the associated meteorites would provide an opportunity for in-hand analysis of a potential near-Earth resource. Author

N91-26039*# Arizona Univ., Tucson.
DISCOVERY AND ORBITAL CHARACTERIZATION OF NEAR-EARTH ASTEROIDS Abstract Only
T. Gehrels, J. Drummond, E. Helin, Martin Hoffmann, D. Rabinowitz, and E. Shoemaker *In its* Resources of Near-Earth Space: Abstracts 1991 p 14 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

The fundamentals of photographic discovery are discussed, and the work at the Palomar Observatory is described including photographic discovery programs elsewhere. The Spacewatch development of CCD-scanning techniques is reviewed. Special searches for objects near the Earth are reported. The existence of four streams among both Earth-approaching asteroids and meteorite-dropping fireballs suggests that at certain times of the year an increase can be expected in both asteroid discoveries and meteoritic events. Author

N91-26040*# Bonn Univ. (Germany, F.R.).
THE SURFACE OF NEAR-EARTH ASTEROIDS Abstract Only
Martin Hoffmann *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 14 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

The surfaces of near-Earth asteroids are expected to differ significantly from those of large objects like the moon because of their different origin and evolution. A selection of such objects for an extensive procurement of material will also be made on criteria like the surface roughness and the rotation rate with respect to the surface gravity. From the currently known distribution of near-Earth asteroid rotation rates it is shown that a significant fraction of them is rotating near their escape velocities. The determination of macroscopic surface roughness from rotation light curves under an assumption of a fractal surface geometry is discussed. Much information is expected from the variation of harmonic expansions of the light curves with the phase angle. Author

N91-26041*# Arizona Univ., Tucson. Lunar and Planetary Lab.
NEAR-INFRARED OBSERVATIONS OF PRIMITIVE ASTEROIDS AND A POSSIBLE EXTINCT COMET Abstract Only **c90**
E. S. Howell and Larry A. Lebofsky *In its* Resources of Near-Earth Space: Abstracts 1991 p 15 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Photometry was obtained simultaneously in the near-infrared and in the visible, of several D-type asteroids, thought to be composed of the most primordial material in the asteroid belt. These objects have been previously classified as D-type based on their low albedo and broadband colors in the visible region of the spectrum. One of the objects observed is 944 Hidalgo, which is possibly an extinct comet, based on its orbital elements. The photometry further constrains the surface mineralogy and is a test of whether differences exist between these objects in different regions of the asteroid belt. Refining the knowledge of the surface composition of these objects will allow a better measure of the amount of thermal processing which has taken place in these so-called primitive asteroids. Spectral slope is assumed to be sensitive to surface composition. There is some variability in spectral slope among those objects classified as D-type, with indications of increasing slope into the near-infrared with heliocentric distance. The spectral features are quite subtle as expected for these low albedo objects, but there is possible evidence of subtle features in some of the D-type asteroids and possibly some active comets. Further analysis of these spectra and the implications for the outer region of the asteroid belt is presented. Author

N91-26042*# Arizona Univ., Tucson. Lunar and Planetary Lab.
CHARACTERIZATION OF LOW ALBEDO ASTEROIDS Abstract Only **c90**
Larry A. Lebofsky and Marcia L. Nelson *In its* Resources of Near-Earth Space: Abstracts 1991 p 15 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Three asteroid classes were defined from the early spectral surveys of the asteroids: C for carbonaceous, M for metallic, and S for stony. Subsequent spectral studies have defined new asteroid classes and have shown that the original classes can be divided into a number of additional asteroid types. The low albedo asteroids are now classified as types B, C, D, F, G, K and P. These types are concentrated in the middle asteroid belt and beyond. Their visible and near infrared spectra are generally featureless and dark, with a red slope in the ultraviolet. Some of them show water absorption features in the mid-infrared, indicating the presence of bound water. The lack of absorption features in the telescopic reflectance spectra has made it difficult to determine the mineralogy of the low albedo asteroids. Some of the asteroid spectra closely resemble laboratory spectra of carbonaceous chondrite meteorites, implying similar mineralogy. These meteorites are chemically primitive, composed of fine-grained matrix material which includes hydrous silicates, complex carbon compounds, olivine and pyroxene, combined with olivine and/or pyroxene chondrules. The main belt low albedo asteroids are probably very similar to these asteroids, but no meteoritic analogues exist for the most distant asteroid types. Author

N91-26043*# Wisconsin Univ., Madison. Center for Space Automation and Robotics.
HELIUM RESOURCES OF MARE TRANQUILLITATIS Abstract Only
Eugene N. Cameron *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 16 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Wisconsin Center for Space Automation and Robotics, Univ. of Wisc., Madison, Wisc. Mare Tranquillitatis, about 300000 sq km in area, is currently the most promising lunar source of He-3 for fueling fusion power plants on Earth. About 60 pct. of the mare regolith consists of particles 100 microns or less in diameter. Helium and other gases derived from the solar wind are concentrated in the fine size fractions. Studies of very small craters indicate that the average regolith exceeds 3 m in areas away from larger craters and other mare features not amenable to mining. There is no evidence of decrease of helium content of regolith and depth. Helium is known to be enriched in regoliths that are high in TiO2 content. Remote sensing indicates that about 90 pct. of Mare Tranquillitatis is covered by regolith ranging from about 6 to +7.5 pct. TiO2; inferred He contents range from 20 to at least 45 wppm total helium (7 to 18 wppb He-3). Detailed studies of craters and inferred ejecta halos displayed on high resolution photographs of the Apollo 11 and Ranger 8 areas suggest that as much as 50 pct. of the mare regolith may be physically minable, on average, with appropriate mining equipment. Assuming that the average thickness of regolith is 3 m, and that 50 pct. of the mare area is minable, the He-3 content of minable regolith containing 20 to 45 wppm total He is estimated at about 94,000 tonnes. Author

N91-26044*# Houston Univ., TX. Inst. of Space Systems Operations.
PRODUCTION OF SOLAR PHOTOVOLTAIC CELLS ON THE MOON Abstract Only
David R. Criswell and Alex Ignatiev *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 16 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Solar energy is directly available on the sunward lunar surface. Most, if not all, the materials are available on the Moon to make silicon based solar photovoltaic cells. A few additional types are possible. There is a small but growing literature on production of lunar derived solar cells. This literature is reviewed. Topics explored include trade-offs of local production versus import of key materials, processing options, the scale and nature of production equipment, implications of storage requirements, and the end-uses of the energy. Directions for future research and demonstrations are indicated. Author

N91-26045*# Arizona Univ., Tucson. Dept. of Civil Engineering and Engineering Mechanics.
DEVELOPMENT AND MECHANICAL PROPERTIES OF STRUCTURAL MATERIALS FROM LUNAR SIMULANTS Abstract Only
Chandra S. Desai, K. Girdner, H. Saadatmanesh, and T. Allen *In its* Resources of Near-Earth Space: Abstracts 1991 p 16 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Development of the technologies for manufacture of structural and construction materials on the Moon, utilizing local lunar soil (regolith), without the use of water, is an important element for habitats and explorations in space. Here, it is vital that the mechanical behavior such as strength and flexural properties, fracture toughness, ductility and deformation characteristics be defined toward establishment of the ranges of engineering applications of the materials developed. The objective is to describe the research results in two areas for the above goal: (1) liquefaction of lunar simulant (at about 100 C) with different additives (fibers, powders, etc.); and (2) development and use of a new triaxial test device in which lunar simulants are first compressed under cycles of loading, and then tested with different vacuums and initial confining or in situ stress. Author

N91-26046*# Lunar and Planetary Inst., Houston, TX.
He-3 AND OTHER LUNAR VOLATILES Abstract Only
B. Fegley, Jr. and T. Swindle (Arizona Univ., Tucson.) *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 17 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Constraints are considered and estimates are given for the abundances of He-3, other noble gases, and chemically reactive volatiles (e.g., H, C, N, S, F, Cl) on the Moon. For the case of surface inventories, solar wind particles implanted into grains on the surface of the Moon provide an accessible, though not necessarily abundant, source of H, C, N and the noble gases. Solar wind implanted species are concentrated in the infest grain

sized, and are only found in the upper few meters of the regolith, where there are grains that have been directly exposed to the Sun. Elemental abundances in surface soils are typically 10s of mg/g, and vary according to the exposure history of the soil. The abundance of the rare, but possibly economically important, isotope He-3 is typically a few mg/g. The largest uncertainty in estimates of the total lunar abundance of solar wind implanted species comes from the lack of knowledge of their distribution with depth below the upper meter or two. For the case of bulk inventories, constraints resulting from lunar sample analyses and from physical chemical models of volatile behavior during the hypothesized giant impact origin of the Moon is used to give estimated abundances.

Author

N91-26047*# Houston Univ., TX. Space Vacuum Epitaxy Center.

SOLAR CELLS FOR LUNAR APPLICATIONS BY VACUUM EVAPORATION OF LUNAR REGOLITH MATERIALS Abstract Only

Alex Ignatiev *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 17 (For primary document see N91-26019 17-91)

Avail: NTIS HC/MF A04 CSCL 03B

The National Space Exploration Initiative, specifically the Lunar component, has major requirements for technology development of critical systems, one of which is electrical power. The availability of significant electrical power on the surface of the Moon is a principal driver defining the complexity of the lunar base. Proposals to generate power on the Moon include both nuclear and solar (photovoltaic) systems. A more efficient approach is to attempt utilization of the existing lunar resources to generate the power systems. Synergism may occur from the fact that there have already been lunar materials processing techniques proposed for the extraction of oxygen that would have, as by-products, materials that could be specifically used to generate solar cells. The lunar environment is a vacuum with pressures generally in the 1 x 10(exp -10) torr range. Such conditions provide an ideal environment for direct vacuum deposition of thin film solar cells using the waste silicon, iron, and TiO2 available from the lunar regolith processing meant to extract oxygen. It is proposed, therefore, to grow by vacuum deposition, thin film silicon solar cells from the improved regolith processing by-products. Author

N91-26048*# Kuck (David L.), Oracle, AZ.

FINDING AND UTILIZING LUNAR LAVA TUBES Abstract Only

David L. Kuck *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 18 (For primary document see N91-26019 17-91)

Avail: NTIS HC/MF A04 CSCL 03B

Horz describes the evidence for lava tubes associated with rills in lunar photoimaging. These tubes have terrestrial counterparts as described by Billings, et al., and Gillet. The widths of these tubes range from 10s to 100s of meters. Their roof thickness are at least 0.125 to 0.25 times their widths and stand unsupported on the Moon. To confine one atmosphere of internal pressure, static roof thickness must be at least 16 m. Favorable locations of lava tubes may be surveyed using roving gravity meters on Doodle Bugs, which consist of platforms containing equipment for communication with Earth-based control stations. The stable -20 C temperature of the lava tubes should provide a workable habitat environment. The greater than 16 m of basalt in the roof should give adequate radiation and impact protection. Typically, after clearing entries and grading ramps, habitats might be placed in tubes and inflated. Later, larger habitats might be built by enclosing tube sections with compacted-regolith dams. The interior can then be sealed to hold an atmosphere. The huge lava tubes inferred from the photographs are capable of providing habitats hundreds of meters wide, in lengths of kilometers. Author

N91-26049*# Kuck (David L.), Oracle, AZ.

LUNAR SULFUR Abstract Only

David L. Kuck *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 18 (For primary document see N91-26019 17-91)

Avail: NTIS HC/MF A04 CSCL 03B

Ideas introduced by Vaniman, Pettit and Heiken in their 1988 Uses of Lunar Sulfur are expanded. Particular attention is given to uses of SO2 as a mineral-dressing fluid. Also introduced is the concept of using sulfide-based concrete as an alternative to the sulfur-based concretes proposed by Leonard and Johnson. Sulfur is abundant in high-Ti mare basalts, which range from 0.16 to 0.27 pct. by weight. Terrestrial basalts with 0.15 pct. S are rare. For oxygen recovery, sulfur must be driven off with other volatiles from ilmenite concentrates, before reduction. Troilite (FeS) may be oxidized to magnetite (Fe3O4) and SO2 gas, by burning concentrates in oxygen within a magnetic field, to further oxidize ilmenite before regrinding the magnetic reconcentration. SO2 is liquid at -20 C, the mean temperature underground on the Moon, at a minimum of 0.6 atm pressure. By using liquid SO2 as a mineral dressing fluid, all the techniques of terrestrial mineral separation become available for lunar ores and concentrates. Combination of sulfur and iron in an exothermic reaction, to form iron sulfides, may be used to cement grains of other minerals into an anhydrous iron-sulfide concrete. A sulfur-iron-aggregate mixture may be heated to the ignition temperature of iron with sulfur to make a concrete shape. The best iron, sulfur, and aggregate ratios need to be experimentally established. The iron and sulfur will be by-products of oxygen production from lunar minerals. Author

N91-26050*# Michigan Technological Univ., Houghton. Dept. of Metallurgical and Materials Engineering.

CONSOLIDATION OF LUNAR REGOLITH: MICROWAVE VERSUS DIRECT SOLAR HEATING Abstract Only

J. Kunitzer, D. G. Strenski, S. J. Yankee, and B. J. Pletka *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 18-19 (For primary document see N91-26019 17-91)

Avail: NTIS HC/MF A04 CSCL 03B

The production of construction materials on the lunar surface will require an appropriate fabrication technique. Two processing methods considered as being suitable for producing dense, consolidated products such as bricks are direct solar heating and microwave heating. An analysis was performed to compare the two processes in terms of the amount of power and time required to fabricate bricks of various size. The regolith was considered to be a mare basalt with an overall density of 60 pct. of theoretical. Densification was assumed to take place by vitrification since this process requires moderate amounts of energy and time while still producing dense products. Microwave heating was shown to be significantly faster compared to solar furnace heating for rapid production of realistic-size bricks. Author

N91-26051*# Boeing Aerospace Co., Huntsville, AL.

COSTS AND BENEFITS OF LUNAR OXYGEN: ENGINEERING, OPERATIONS, AND ECONOMICS Abstract Only

Brent Sherwood and Gordon R. Woodcock *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 19 Sponsored by NASA. Ames Research Center (For primary document see N91-26019 17-91)

Avail: NTIS HC/MF A04 CSCL 03B

Oxygen is the most commonly discussed lunar resource. It will certainly not be the easiest to retrieve, but oxygen's fundamental place in propulsion and life support guarantees it continued attention as a prime candidate for early in situ resource utilization (ISRU). The findings are reviewed of recent investigation, sponsored by NASA-Ames, into the kinds of technologies, equipment, and scenarios (the engineering and operations costs) that will be required even to initiate lunar oxygen production. The infrastructure necessary to surround and support a viable oxygen-processing operation is explained. Selected details are used to illustrate the depth of technology challenges, extent of operations burdens, and complexity of decision linkages. Basic assumptions, and resulting timelines and mass manifests, are listed. These findings are combined with state-of-the-art knowledge of lunar and Mars propulsion options in simple economic input/output and internal-rate-of-return models, to compare production costs with

performance benefits. Implications for three realistic scales of exploration architecture - expeditionary, aggressive science, and industrialization/settlement - are discussed. Conclusions are reached regarding the contextual conditions within which production of lunar oxygen (LLOX) is a reasonable activity. LLOX appears less useful for Mars missions than previously hoped. Its economical use in low Earth orbit hinges on production of lunar hydrogen as well. LLOX shows promise for lunar ascent/descent use, but that depends strongly on the plant mass required. Author

N91-26052*# Texas Univ., Austin. Dept. of Astronomy.
INDUSTRIAL MODIFICATION OF THE LUNAR ATMOSPHERE Abstract Only
Harlan J. Smith *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 19 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

The sources and sinks of the present trace lunar atmosphere can be accounted for. In particular, it is clear that the solar wind is the primary agent for rapidly removing gases, other than H2 which can escape thermally. But the solar wind has only a finite capability for stripping. If gases are added at rates approaching 100 g/sec, an atmosphere will begin to accumulate. Transition to a state where thermal escape dominates, solar wind loss occurs when the atmosphere has accumulated a total mass of about 108 kg. Assuming that disturbing the lunar regolith liberates about 10-4 by mass of trapped gases, this implies that some kinds of mining operation could handle up to 109 tons of material before creating a long lived, albeit still exceedingly tenuous, atmosphere which would have no appreciable influence on most lunar activities. Should the lunar atmosphere ever exceed an abundance matching that of the Earth at 120 km altitude, ever larger UV wavelengths ranges would be inhibited or lost, as would probably be the ability to use the Moon as a base for very low frequency radio astronomy. Author

N91-26053*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
LUNAR BASE SITING Abstract Only
Robert L. Staehle and Richard Dowling (World Space Foundation, Pasadena, CA.) *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 20 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

As with any planetary body, the lunar surface is quite heterogeneous. There are widely dispersed sites of particular interest for known and potential resource availability, selenology, and lunar observatories. Discriminating characteristics include solar illumination, view of earth, local topography, engineering properties of the regolith and certain geological features, and local mineralogy and petrology. Space vehicle arrival and departure trajectories constitute a minor consideration. Over time, a variety of base sites will be developed serving different purposes. Resource-driven sites may see the fastest growth during the first decades of lunar development, but selection of the most favorable sites is likely to be driven by suitability for a combination of activities. As on earth, later development may be driven by geographical advantages of surface transportation routes. With the availability of near-constant sunlight for power generation, as well as permanently shadowed areas at cryogenic temperatures, polar sites are attractive because they require substantially less earth-launched mass and lower equipment complexity for an initial permanent base. Discovery of accessible volatiles reservoirs, either in the form of polar permafrost or gas reservoirs at other locations, would dramatically increase the attractiveness of any site from a logistical support and selenological point of view. Amid such speculation, no reliable evidence of such volatiles exist. More reliable evidence exists for areas of certain mineral concentrations, such as ilmenite, which could form a feedstock for some proposed resource extraction schemes. While tentative selections of advantageous base sites are made, new data from lunar polar orbiters and the Galileo polar flybys would be very helpful. Author

N91-26054*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
AN ISU STUDY OF ASTEROID MINING Abstract Only **c90**
J. D. Burke *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 20 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

During the 1990 summer session of the International Space University, 59 graduate students from 16 countries carried out a design project on using the resources of near-earth asteroids. The results of the project, whose full report is now available from ISU, are summarized. The student team included people in these fields: architecture, business and management, engineering, life sciences, physical sciences, policy and law, resources and manufacturing, and satellite applications. They designed a project for transporting equipment and personnel to a near-earth asteroid, setting up a mining base there, and hauling products back for use in cislunar space. In addition, they outlined the needed precursor steps, beginning with expansion of present ground-based programs for finding and characterizing near-earth asteroids and continuing with automated flight missions to candidate bodies. (To limit the summer project's scope the actual design of these flight-mission precursors was excluded.) The main conclusions were that asteroid mining may provide an important complement to the future use of lunar resources, with the potential to provide large amounts of water and carbonaceous materials for use off earth. However, the recovery of such materials from presently known asteroids did not show an economic gain under the study assumptions; therefore, asteroid mining cannot yet be considered a prospective business. Author

N91-26055*# Arizona Univ., Tucson. Lunar and Planetary Lab.
DEVELOPMENT OF AN ELECTROSTATIC PROPULSION ENGINE USING SUB-MICRON POWDERS AS THE REACTION MASS Abstract Only **c20**
F. Herbert and K. R. Kendall *In its* Resources of Near-Earth Space: Abstracts 1991 p 21 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Asteroid sample return missions would benefit from development of an improved rocket engine. Chemical rockets achieve their large thrust with high mass consumption rate (dm/dt) but low exhaust velocity; therefore, a large fraction of their total mass is fuel. Present day ion thrusters are characterized by high exhaust velocity, but low dm/dt; thus, they are inherently low thrust devices. However, their high exhausy velocity is poorly matched to typical mission requirements and therefore, wastes energy. A better match would be intermediate between the two forms of propulsion. This could be achieved by electrostatically accelerating solid powder grains, raising the possibility that interplanetary material could be processed to use as reaction mass. An experiment to study the charging properties of sub-micron sized powder grains is described. If a suitable material can be identified, then it could be used as the reaction mass in an electrostatic propulsion engine. The experiment employs a time of flight measurement to determine the exhaust velocity (v) of various negatively charged powder grains that were charged and accelerated in a simple device. The purpose is to determine the charge to mass ratio that can be sustained for various substances. In order to be competitive with present day ion thrusters, a specific impulse (v/g) of 3000 to 5000 seconds is required. Preliminary results are presented. More speculatively, there are some mission profiles that would benefit from collection of reaction mass at the remote asteroid site. Experiments that examine the generation of sub-micron clusters by electrostatic self-disruption of geologically derived material are planned. Author

N91-26056*# Arizona Univ., Tucson. Lunar and Planetary Lab.
ENSTATITE CHONDRITES AND ACHONDRITES AS ASTEROIDAL RESOURCES Abstract Only **c90**
M. L. Hutson and John S. Lewis *In its* Resources of Near-Earth Space: Abstracts 1991 p 21 (For primary document see

N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

The highly reduced nature of the enstatite meteorites (chondrites and achondrites) differs from that of all other types of stony meteorites. The silicates in the enstatite meteorites contain almost no FeO. In addition, many normally lithophile elements such as Na, Ca, Mg, Cr, and Ti display chalcophilic behavior. A study of the chemistry and mineralogy of the enstatite meteorites was undertaken to determine their resource potential. On average, about 99 percent of the volume of an enstatite achondrite, or aubrite, consists of only four silicate minerals: enstatite, Na-rich plagioclase, diopside, and forsterite, with enstatite being by far the most abundant mineral. The remaining one percent of the volume consists of troilite, kamacite, and trace amounts of oldhamite, daubreeiite, ferromagnesian albandite, and schreibersite. Thus, the aubrites can be considered as a possible source for large quantities of Mg, Si, and O, but are of little interest as a source of anything else. The enstatite chondrites appear to be more promising candidates for resource utilization. The chondrites are generally divided into two groups: EH (high iron, fine-grained, with abundant chondrules); and EL (low iron, coarse-grained, with little or no evidence of chondrules). Metallic Ni-Fe makes up roughly 20-25 weight percent of each type of enstatite chondrite. These meteorites are also a good source of nitrogen. This is due in part to the presence of osbornite and sinoite. The latter mineral is restricted to EL chondrites, which typically have a higher bulk nitrogen content than the EH chondrites. Three valuable metals, Cr, Mn, and Ti, are concentrated in a few distinct sulfide phases in the enstatite chondrites. These sulfide phases are troilite and niningerite in EH chondrites and troilite, daubreelite, and ferroan alabandite in EL chondrites. Author

N91-26057*# Jet Propulsion Lab., California Inst. of Tech., Pasadena. Earth and Space Sciences Div.
SHORT-PERIOD COMETS Abstract Only c90
Paul R. Weissman and Humberto Campins (Florida Univ., Gainesville.) *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 22 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

The spacecraft flybys of Comet Halley in 1986 confirmed Whipple's icy conglomerate hypothesis for cometary nuclei and showed that comets are far richer in volatiles than any other class of solar system bodies. Water is the most abundant volatile, comprising roughly 80 percent of the gas flowing out from the nucleus. Carbon monoxide is next with a content of 15 percent relative to water, though with approximately half of that coming from an extended source in the cometary coma, i.e., hydrocarbon dust grains. The detection of large numbers of hydrocarbon CHON grains was one of the more significant discoveries of the Halley flybys, as was the ground-based observation that CN occurs in jets, again indicating an extended source. Evidence was also found for more complex hydrocarbons. Estimates of the total dust-to-gas ratio for Halley range as high as 2:1, indicating that a substantial fraction of the volatile material may be tied up in solid hydrocarbons rather than ices. The role of clathrates in trapping more volatile ices is not yet understood. If Halley can be taken to be representative of all short-period comets, then the short-period comets may provide a significant source of volatiles in near-earth space. This resource is more difficult to reach dynamically than the near-earth asteriods, but the high volatile content may justify the additional effort necessary. In addition, there is considerable evidence that at least some fraction of the near-earth asteriods are extinct cometary nuclei which have evolved into asteroid orbits, and which may contain significant volatiles buried beneath an insulating lag-deposit crust of nonvolatiles. Knowledge of comets will be greatly enhanced in the near future by the Comet Rendezvous Flyby mission now under development by NASA, and by the proposed Rosetta mission. Author

N91-26058*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NEAR-EARTH ASTEROIDS: METALS OCCURRENCE, EXTRACTION, AND FABRICATION Abstract Only c90
Richard Westfall *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 22 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Near-earth asteroids occur in three principle types of orbits: Amor, Apollo, and Aten. Amor asteroids make relatively close (within 0.3 AU) approaches to the earth's orbit, but do not actually overlap it. Apollo asteroids spend most of their time outside the earth's orbital path, but at some point of close approach to the sun, they cross the orbit of the earth. Aten asteroids are those whose orbits remain inside the earth's path for the majority of their time, with semi-major axes less than 0.1 AU. Near-earth orbit asteroids include: stones, stony-irons, irons, carbonaceous, and super-carbonaceous. Metals within these asteroids include: iron, nickel, cobalt, the platinum group, aluminum, titanium, and others. Focus is on the extraction of ferrous and platinum group metals from the stony-iron asteroids, and the iron asteroids. Extraction of the metal fraction can be accomplished through the use of tunnel-boring-machines (TBM) in the case of the stony-irons. The metals within the story-iron asteroids occur as dispersed granules, which can be separated from the stony fraction through magnetic and gaseous digestion separation techniques. The metal asteroids are processes by drilling and gaseous digestion or by gaseous digestion alone. Manufacturing of structures, housings, framing networks, pressure vessels, mirrors, and other products is accomplished through the chemical vapor deposition (CVD) of metal coating on advanced composites and on the inside of contour-defining inflatables (CDI). Metal coatings on advanced composites provide: resistance to degradation in the hostile environments of space; superior optical properties; superior heat dissipation; service as wear coatings; and service as evidential coatings. Metal coatings on the inside of CDI produce metal load-bearing products. Fibers such as graphite, kevlar, glass, ceramic, metal, etc., can be incorporated in the metal coatings on the inside of CDI producing metal matrix products which exhibit high strength and resist crack propagation. Author

N91-26059*# Analex Corp., Cleveland, OH.
MOMENTUM HARVESTING TECHNIQUES FOR SOLAR SYSTEM TRAVEL Abstract Only c90
Alan J. Willoughby *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 23 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Astronomers are lately estimating there are 400,000 earth visiting asteroids larger than 100 meters in diameter. These asteroids are uniquely accessible sources of building materials, propellants, oxygen, water, and minerals. They also constitute a huge momentum reserve, potentially usable for travel throughout the solar system. To use this momentum, these stealthy objects must be tracked and the ability to extract the desired momentum obtained. Momentum harvesting by momentum transfer from asteroid to spacecraft, and by using the momentum of the extraterrestrial material to help deliver itself to its destination is discussed. The purpose is neither to quantify nor justify the momentum exchange processes, but to stimulate collective imaginations with some intriguing possibilities which emerge when momentum as well as material is considered. A net and tether concept is the suggested means of asteroid capture, the basic momentum exchange process. The energy damping characteristics of the tether determines the velocity mismatch that can be tolerated, and hence the amount of momentum that can be harvested per capture. As the tether plays out of its reel, drag on the tether steadily accelerates the spacecraft and dilutes, in time, the would-be collision. A variety of concepts for riding and using asteroids after capture are introduced. The hitchhiker uses momentum transfer only. The beachcomber, the caveman, the swinger, the prospector, and the rock wrecker also take advantage of raw asteroid materials. The chemist and the hijacker go further,

they process the asteroid into propellants. Or, an asteroid railway system could be constructed with each hijacked asteroid becoming a scheduled train. Travelers could board this space railway system assured that water, oxygen propellants, and shielding await them. Austere space travel could give way to comforts, with a speed and economy impossible without nature's gift of earth visiting asteroids. Author

N91-26060*# Analex Corp., Cleveland, OH.
STACKING THE ODDS IN FAVOR OF A SPACE PROPULSION JACKPOT Abstract Only **c20**
Alan J. Willoughby *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 23 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

When faced with a variety of technical options to solve a problem, program planners often try to identify one potential winner, then channel their resources into this option. The more scarce their resources are perceived to be, the more likely they are to fall into this trap of illogic. The real ideal solution could well be an optimum combination of options, not just one. Many propulsion opportunities are tantalizing solutions to the potentially high cost of travelling to other planets. Among these opportunities, nuclear thermal rockets (NTR), nuclear electric propulsion (NEP), and asteroid derived propellants stand out as high-payoff modest-challenge options, as near term as they are resolved to be made. But which to choose? Or should higher risk higher payoff technology be opted for, such as fusion? The approach advocated here, technoflex, is one that addresses NTR, NEP, and asteroid propellants in harmony rather than in isolation. Technoflex is technology rich, and option flexible. Technoflex should cost roughly the same as a classic phased technology elimination approach. The synergistic benefits amongst these three options, how they can be efficiently pursued together, and how they can fit with longer range technologies are stressed. Even if no single option reaches its highest expectations, the combinations of any two partial winners would still give big dividends. These combinations are cheap propellants in space, dual mode high thrust/low thrust, or versatile propellant NTR. The triple payoff is excellent, even if all three options would pan out below expectations. If only one option reaches its potential, it could make the other two still worth their investment. If all three options meet full expectations, the triple payoff is a space propulsion jackpot which makes concern about the initial investment ludicrous as well as open up the solar system to expedient exploration. Author

N91-26061*# Brown Univ., Providence, RI. Dept. of Geological Sciences.
THE COMPOSITION OF PHOBOS: METEORITE ANALOGS BASED ON KRFM AND VSK SPECTRAL DATA FROM THE PHOBOS 2 SPACECRAFT Abstract Only **c90**
D. T. Britt and S. L. Murchie *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 24 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

In 1989 the Phobos 2 spacecraft obtained 8-channel 0.3 to 0.6 mm KRFM spectra and two-channel wide-angel TV VSK images in bandpasses of 0.40 to 0.56 mm and 0.78 to 1.10 mm. The TV data were used to map four color ratio units on disk-resolved images of Phobos, and were combined with the KRFM spectra to analyze possible meteorite analogs for the mapped units. A total of 58 spectra of 39 meteorites were studied for similarities with Phobos data in spectral shape, absorption features, and visible near-IR color ratio. Analysis of the spectral data show that, among the meteorites studied, there are no unique spectral analogs for Phobos surface material. Currently, the closest spectral analogs are the optically altered black chondrite meteorites Gorlovka and Pervomaisky. The weak UV absorption bands in some KRFM spectra and the red slope in VSK color-ratio data indicate that carbonaceous chondrite-like material may also be a component of Phobos surface material. However, the lack of close carbonaceous chondrite spectral analogs and the existence of apparent absorption bands in KRFM spectra that are not seen in meteorite spectra suggest that there are processes and/or materials on the surface of Phobos that are not represented in the meteorite collections. The similarities between KRFM spectra of Phobos and the spectra of black chondrites suggest that optically altered mafic silicates may constitute a component of the surface material of Phobos, and that optical alteration and mixing by regolith processes may be an important factor in the evolution of Phobos surface material. Author

N91-26062*# Martin Marietta Corp., Denver, CO. Astronautics Group.
SURVEY OF RESOURCE OPPORTUNITIES AND CRITICAL EVALUATION OF ECONOMIC REQUIREMENTS Abstract Only **c12**
Benton C. Clark *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 24 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 22A

A series of mission analyses were performed to evaluate human mission to Mars and the moon with and without the aid of planetary resource utilization. The types of trade studies that are considered include the use of resources to manufacture propellant, food, habitat atmospheric gases, and lander habitat structure. Also, the potential for export of resources from the moon, Mars, Phobos, Deimos, and selected asteroids is also examined. In all cases, mass leveraging is evaluated. For certain cases, economic factors are evaluated as well. It is concluded that some uses are highly leveraging on the mission, whereas others have lesser impact and, therefore, should be afforded lesser priority in resource utilization studies. This survey is made with a consistent set of scaling laws for spacecraft propulsion and habitation systems and subsystems, and therefore, provides a rational basis for comparing different resource locations and use strategies. Author

N91-26063*# General Dynamics Corp., San Diego, CA. Laser Systems Lab.
MASS BUDGET FOR MINING THE MOONS OF MARS Abstract Only
Anthony Zuppero and Geoffrey A. Landis (Sverdrup Technology, Inc., Brook Park, OH.) *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 24 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

The mass budget is detailed for system architectures that use rocket fuels of propellants derived from Deimos and Phobos to transport 10000 ton payloads of exofuel (exoatmospheric fuels) or exomass (exoatmospheric mass) to earth orbits. A point design for the system architecture is used that includes a self-sustaining cycle, which requires no materials from earth, and an infrastructure, which must be emplaced to start the cycle. Both the use of steam rockets and the use of liquid oxygen and liquid hydrogen is examined. It is shown that a system delivering 10000 tons of payload to a highly elliptical earth orbit requires approximately 23000 tons of water for use by nuclear heated steam rockets to effect completely propulsive, round trip maneuvers. It is also shown that about 8000 tons will be available for sale at low earth orbit, each cycle, and that the number of cycles can number in the tens before critical components are replaced. Author

N91-26064*# General Dynamics Corp., San Diego, CA. Laser Systems Lab.
OPTIMUM ROCKET PROPULSION FOR ENERGY-LIMITED TRANSFER Abstract Only **c20**
Anthony Zuppero and Geoffrey A. Landis (Sverdrup Technology, Inc., Brook Park, OH.) *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 25 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 22H

In order to effect large-scale return of extraterrestrial resources to Earth orbit, it is desirable to optimize the propulsion system to maximize the mass of payload returned per unit energy expended. This optimization problem is different from the conventional rocket propulsion optimization. A rocket propulsion system consists of

an energy source plus reaction mass. In a conventional chemical rocket, the energy source and the reaction mass are the same. For the transportation system required, however, the best system performance is achieved if the reaction mass used is from a locally available source. In general, the energy source and the reaction mass will be separate. One such rocket system is the nuclear thermal rocket, in which the energy source is a reactor and the reaction mass a fluid which is heated by the reactor and exhausted. Another energy-limited rocket system is the hydrogen/oxygen rocket where H2/O2 fuel is produced by electrolysis of water using a solar array or a nuclear reactor. The problem is to choose the optimum specific impulse (or equivalently exhaust velocity) to minimize the amount of energy required to produce a given mission delta-v in the payload. The somewhat surprising result is that the optimum specific impulse is not the maximum possible value, but is proportional to the mission delta-v. In general terms, at the beginning of the mission it is optimum to use a very low specific impulse and expend a lot of reaction mass, since this is the most energy efficient way to transfer momentum. However, as the mission progresses, it becomes important to minimize the amount of reaction mass expelled, since energy is wasted moving the reaction mass. Thus, the optimum specific impulse will increase with the mission delta-v. Optimum I(sub sp) is derived for maximum payload return per energy expended for both the case of fixed and variable I(sub sp) engines. Sample missions analyzed include return of water payloads from the moons of Mars and of Saturn. Author

N91-26065*# Arizona Univ., Tucson. Lunar and Planetary Lab.
WATER RESOURCES AND HYDROLOGY OF MARS Abstract Only
V. R. Baker, V. C. Gulick, J. S. Kargel, and R. G. Strom *In its* Resources of Near-Earth Space: Abstracts 1991 p 26 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

The surface of Mars has been extensively modified by a large variety of water erosional and depositional processes. Although liquid water is presently unstable on the planet's surface, in its cold, hyperarid climate, there is abundant geomorphological evidence of past fluvial valley development multiple episodes of catastrophic flooding, periglacial landforms, ice-related permafrost, lake deposits, eroded impact craters and possible glacial landforms throughout much of Mars' geological history. The amount of water required to form such features is estimated to be equivalent to a planet-wide layer approximately 50 meters deep. Some of this water undoubtedly was removed from the planet by atmospheric escape processes, but much probably remains in the subsurface of Mars. Jakosky summarized the present partitioning of water on Mars, expressed as an average global depth, as follows: in the polar caps, 30 meters; in the megaregolith, 500 to 1000 meters; structurally bound in clays, 10 meters; and in high latitude regolith, a few meters. However, most of this water is probably in the form of ice, except in anomalous areas of possible near surface liquid water, and in regions where hydrothermal systems are still active. The best locations for prospecting are those areas where water or ice is sufficiently concentrated at shallow enough depths to make it feasible to pump out or mine. Author

N91-26066*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
MARTIAN IMPACT CRATER EJECTA MORPHOLOGIES AND THEIR POTENTIAL AS INDICATORS OF SUBSURFACE VOLATILE DISTRIBUTION Abstract Only
Nadine G. Barlow *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 27 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Many martian impact craters ejecta morphologies suggestive of fluidization during ejecta emplacement. Impact into subsurface volatile reserviors (i.e., water, ice, CO2, etc.) is the mechanism favored by many scientists, although acceptance of this mechanism is not unanimous. In recent years, a number of studies were undertaken to better understand possible relationships between ejecta morphology and latitude, longitude, crater diameter, and terrain. These results suggest that subsurface volatiles do influence the formation of specific ejecta morphologies and may provide clues to the vertical and horizontal distribution of volatiles in more localized regions of Mars. The location of these volatile reservoirs will be important to humans exploring and settling Mars in the future. Qualitative descriptions of ejecta morphology and quantitative analyses of ejecta sinuosity and ejecta lobe areal extent from the basis of the studies. Ejecta morphology studies indicate that morphology is correlated with crater diameter and latitude, and, using depth-diameter relationships, these correlations strongly suggest that changes in morphology are related to transition among subsurface layers with varying amounts of volatiles. Ejecta sinuosity studies reveal correlations between degree of sinuosity (lobateness) and crater morphology, diameter, latitude, and terrain. Lobateness, together with variations in areal extent of the lobate ejecta blanket with morphology and latitude, probably depends most directly on the ejecta emplacement process. The physical parameters measured here can be compared with those predicted by existing ejecta emplacement models. Some of these parameters are best reproduced by models requiring incorporation of volatiles within the ejecta. However, inconsistencies between other parameters and the models indicate that more detailed modeling is necessary before the location of volatile reservoirs can be confidently predicted based on ejecta morphology studies alone. Author

N91-26067*# Massachusetts Inst. of Tech., Cambridge. Dept. of Earth, Atmospheric and Planetary Sciences.
EVOLUTION OF ORE DEPOSITS ON TERRESTRIAL PLANETS Abstract Only
R. G. Burns *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 27 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Ore deposits on terrestrial planets materialized after core formation, mantle evolution, crustal development, interactions of surface rocks with the hydrosphere and atmosphere, and, where life exists on a planet, the involvement of biological activity. Core formation removed most of the siderophilic and chalcophilic elements, leaving mantles depleted in many of the strategic and noble metals relative to their chondritic abundances. Basaltic magma derived from partial melting of the mantle transported to the surface several metals contained in immiscible silicate and sulfide melts. Magmatic ore deposits were formed during cooling, fractional crystallization and density stratification from the basaltic melts. Such ore deposits found in earth's Archean rocks were probably generated during early histories of all terrestrial planets and may be the only types of igneous ores on Mars. Where plate tectonic activity was prevalent on a terrestrial planet, temporal evolution of ore deposits took place. Repetitive episodes of subduction modified the chemical compositions of the crust and upper mantles, leading to porphyry copper and molybdenum ores in calc-alkaline igneous rocks and granite-hosted tin and tungsten deposits. Such plate tectonic-induced mineralization in relatively young igneous rocks on earth may also have produced hydrothermal ore deposits on Venus in addition to the massive sulfide and cumulate chromite ores associated with Venusian mafic igneous rock. Sedimentary ore deposits resulting from mechanical and chemical weathering in reducing atmospheres in Archean earth included placer deposits (e.g., uraninite, gold, pyrite ores). Chromite, ilmenite, and other dense unreactive minerals could also be present on channel floors and in valley networks on Mars, while banded iron formations might underlie the Martian northern plains regions. As oxygen evolved in earth's atmosphere, so too did oxide ores. By analogy, gossans above sulfide ores probably occur on Mars, but not submarine ferromanganese nodules and crusts which have precipitated in oxygenated seawater on earth. Author

N91-26068*# General Dynamics Corp., San Diego, CA. Space Systems Div.
THE POTENTIAL FOR CRUSTAL RESOURCES ON MARS Abstract Only
Bruce M. Cordell and Stephen L. Gillett (Nevada Univ., Reno.)

In Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 28 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Martian resources pose not only an interesting scientific challenge but also have immense astronautical significance because of their ability to enhance mission efficiency, lower launch and program costs, and stimulate the development of large Mars surface facilities. Although much terrestrial mineralization is associated with plate tectonics and Mars apparently possesses a thick, stationary lithosphere, the presence of crustal swells, rifting, volcanism, and abundant volatiles indicates that a number of sedimentary, hydrothermal, dry-magma mineral concentration processes may have operated on Mars. For example, in Colorado Plateau-style (roll-front) deposits, uranium precipitation is localized by redox variations in groundwater. Also, evaporites (either in salt pans or even interstitially in pore spaces) might concentrate Cl, Li, and K. Many Martian impact craters have been modified by volcanism and probably have been affected by rising magma bodies interacting with ground ice or water. Such conditions might produce hydrothermal circulations and element concentrations. If the high sulfur content found by the Viking landers typifies Martian abundances, sulfide ore bodies may have been formed locally. Mineral-rich Africa seems to share many volcanic and tectonic characteristics with portions of Mars and may suggest Mars' potential mineral wealth. For example, the rifts of Valles Marineris are similar to the rifts in east Africa, and may both result from a large mantle plume rising from the interior and disrupting the surface. The gigantic Bushveld complex of South Africa, an ancient layered igneous intrusion that contains ores of chromium and Pt-group metals, illustrates the sort of dry-magma processes that also could have formed local element concentrations on Mars, especially early in the planet's history when heat flow was higher. Author

N91-26069*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
OPTIONS FOR MARTIAN PROPELLANT PRODUCTION Abstract Only
Warren Dowler, James French, and Kumar Ramohalli (Arizona Univ., Tucson.) *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 28 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

A quantitative evaluation methodology for utilizing in-situ resources on Mars for the production of useful substances. The emphasis is on the chemical processes. Various options considering different feedstock (mostly, carbon dioxide, water, and iron oxides) are carefully examined for the product mix and the energy needs. Oxygen, carbon monoxide, alcohols, and other chemicals are the end products. The chemical processes involve electrolysis, methanation, and variations. It is shown that maximizing the product utility is more important than the production of oxygen, methane, or alcohols. An important factor is the storage of the chemicals produced. The product utility is dependent, to some extent, upon the mission. A combination of the stability, the enthalpy of formation, and the mass fraction of the products is seen to yield a fairly good quantitative feel for the overall utility and maximum mission impact. Author

N91-26070*# State Univ. of New York, Plattsburgh. Dept. of Physics.
THE METEORITIC CONTRIBUTION TO THE REGOLITHS OF MARS, DEIMOS, AND PHOBOS Abstract Only **c90**
G. J. Flynn *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 29 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

The mass influx of meteoritic material at Earth exhibits two distinct peaks: one centered at 10-5 grams, corresponding to the continuous, planet-wide flux of micrometeorites, and a second corresponding to the rare impacts of objects larger than 1014 grams. Using the measured flux of meteoritic material at Earth and estimates of the Mars/Earth flux ration, it was calculated that the micrometeorites add between 2,700 and 59,000 tons of meteoritic material to the surface of Mars annually. This corresponds to the accretion of between 1.8 and 40 cm of meteoritic material per billion years. On the Moon this meteoritic component constitutes 1 to 2 percent of the mare soils. Depending on the indigenous regolith production rate on Mars, the meteoritic material on Mars may be present in sufficient concentration to serve as a resource for the volatile and siderophile elements common in chondritic meteorites but rare in basaltic crustal material. Since a significant fraction of the micrometeorites less than 1200 mm in diameter survive atmospheric entry on Mars without melting, they carry into the regolith the solar wind ions, including H, He, and noble gases, implanted during their space exposure. Author

N91-26071*# Academy of Sciences, Potsdam (German D.R.). Zentralinstitut fuer Physik der Erde.
PLANETARY SURFACE STRUCTURE AND EVOLUTION OF MARS Abstract Only
Siegfried Franck *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 29 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

The surface of the planet Mars is characterized by two different hemispheres: old densely cratered structures in the Southern Uplands, and sparsely cratered younger topographically lower regions covering approximately the northern third of the planet's surface. The model for explaining these global surface structures is characterized by the following features: (1) homogeneous accretion of Mars; (2) formation of a metal melt layer; (3) northward translation of the undifferentiated core due to a Rayleigh-Taylor instability; (4) vigorous convection in the southern parts and formation of the Southern Uplands' crust; (5) fragmentation of the primordial core, slowly dissolving rockbergs, beginning of Tharsis uplift and volcanism; (6) formation of the Northern Lowlands' crust from only weakly differentiated silicatic material; and (7) reaching of the present state with symmetrically placed core and further thermal evolution. Author

N91-26072*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
GETTING WATER FROM THE WATER OF HYDRATION ON MARS
O. Gwynne, J. P. Cozzatti, A. P. Zent, and C. P. McKay *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 30 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Both Viking landers found evidence of water in small concentration in the soils of Mars. Using the gas chromatograph mass spectrometer the soil samples on Mars were heated to 500 C to release the water. This result lead researchers to believe that the water in the soil of Mars was tightly bound in a hydration state. In the laboratory several Mars analog soils and a few bench mark soils were run through a microwave to determine the amount of water released using this method. The results suggest that sufficient water can be obtained using this method to augment the activities of a human base on Mars. Author

N91-26073*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
CHEMICAL APPROACHES TO CARBON DIOXIDE UTILIZATION FOR MANNED MARS MISSIONS Abstract Only
Aloysius F. Hepp, Geoffrey A. Landis, and Clifford P. Kubiak (Purdue Univ., West Lafayette, IN.) *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 30 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Utilization of resources available in situ is a critical enabling technology for permanent human presence in space. A permanent presence on Mars, for example, requires a tremendous infrastructure to sustain life under hostile conditions (low oxygen, partial pressure, ultraviolet radiation, low temperature, etc.). There are numerous studies on the most accessible of Martian resources: atmospheric carbon dioxide. As a resource on Mars, atmospheric

CO2 is: (1) abundant; (2) available at all points on the surface; (3) of known presence, requiring no precursor mission to verify; (4) chemically simple; and (5) can be obtained by simple compression, with no requirements of mining or beneficiation equipment operation. Several novel proposals are presented for CO2 fixation through chemical, photochemical, and photoelectrochemical means. Author

N91-26074*# Colorado Univ., Boulder. Lab. for Atmospheric and Space Physics.
WATER ON MARS: VOLATILE HISTORY AND RESOURCE AVAILABILITY Abstract Only
Bruce M. Jakosky *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 31 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

The existence of water on Mars is undisputed today. Measurements of atmospheric water vapor have shown that the abundance varies with location and season in a systematic way which depends on processes of exchange with the polar caps, regolith, and atmosphere. Channels, which give the appearance of having been carved by water or of having had water involved in their formation, appear in various locations on the surface; some were formed by catastrophic outflow of water from beneath the surface, while others form valley networks which give the appearance of having formed over long periods of time primarily early in the planet's history. The north polar residual cap consists of water ice, possibly containing an amount of water equivalent to a global layer several tens of meters thick. Finally, water is observed within the regolith, as adsorbed water or as water of hydration. Author

N91-26075*# Boulder Center for Science and Policy, CO.
ATMOSPHERIC WATER ON MARS, ENERGY ESTIMATES FOR EXTRACTION Abstract Only
Tom Meyer *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 32 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

The Mars atmosphere is considered as a resource for water to support a human expedition. Information obtained from the Viking mission is used to estimate the near-surface water vapor level. The variability over the diurnal cycle is examined and periods of greatest water abundance are identified. Various methods for extracting atmospheric water are discussed including energy costs and the means for optimizing water extraction techniques. Author

N91-26076*# California Univ., Los Angeles. Dept. of Earth and Space Sciences.
THE GLOBAL DISTRIBUTION OF MARTIAN PERMAFROST Abstract Only
David A. Paige *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 32 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Accurately determining the present global distribution of Martian ground ice will be an important step towards understanding the evolution of the Martian surface and atmosphere, and could greatly facilitate human and robotic exploration of the planet. The quantitative Mars permafrost studies demonstrated the potential importance of a number of factors determining the past and present distribution of subsurface ice on Mars, but have not considered the issue of regional variability. To consider the distribution of Mars permafrost in greater detail a new thermal model was developed that can calculate Martian surface and subsurface temperatures as a function of time-of-day and season. The results indicate that the distribution of Martian permafrost is highly sensitive to the bulk thermal properties of the overlying soil. Viking IRTM observations of diurnal surface temperature variations show that the bulk thermal properties of midlatitude surface materials exhibit a high degree of regional inhomogeneity. In general, the results show that the global distribution of permafrost is at least as sensitive to the thermal properties of the overlying surface material as it is to variations in surface isolation due to large scale variations in Mars' orbital and axial elements. In particular, they imply that subsurface ice may exist just a few centimeters below the surface in regions of low thermal inertia and high albedo, which are widespread at latitudes ranging from the equator to +60 degrees latitude. Author

N91-26077*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
MARS OBSERVER: A GLOBAL MAPPING MISSION Abstract Only
Frank K. Palluconi and Arden L. Albee (California Inst. of Tech., Pasadena.) *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 33 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Mars Observer will be launched in September 1991, arrive at Mars in August 1993, and begin mapping in December 1993. Mapping will be conducted from a low-altitude (400 km) polar orbit over a period of one Martian year (687 days). Each of the seven instruments will be able to observe Mars continuously over this period. The scientific mission centers on global Geoscience and Climatology observations of the Mars atmosphere, surface, and interior. The seven experiments involve gamma-ray and neutron spectroscopy, magnetometry, surface and atmospheric imaging, atmospheric sounding, laser altimetry, gravity mapping, and thermal emission spectroscopy. Author

N91-26078*# Worcester Polytechnic Inst., MA. Dept. of Chemistry.
THE FORMATION OF PEROXONITRITES AND OXYGEN ON MARS Abstract Only
Robert C. Plumb and John O. Edwards (Brown Univ., Providence, RI.) *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 33 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

When Martian regolith samples are moistened with water, a strong oxidant and oxygen gas are released. The many possible oxidants which have been suggested as present, including superoxide (O2(-)) hydrogen peroxide (H2O2(-)), and manganese (IV) oxide (MnO2), as well as peroxonitrite (ONOO(-)), can be distinguished by their ability to account for the numerous observations of the Viking Labelled Release (LR) and Gas Exchange (GEX) experiments. The magnitudes, kinetics, and heat labilities of the LR experiments and the magnitudes and heat labilities of the GEX experiments have been quantitatively replicated with peroxonitrites. Further, it is to be expected from information about the photochemistry of nitrogen in the atmosphere, the calculated fluxes of the NO(x) to the surface, the known reactions of NO(x) with carbonates to produce nitrates and photolysis studies of nitrates, that peroxonitrites are present on Mars. However, considerable uncertainty has existed about the form in which oxygen is stored in photolyzed nitrate crystals. Models have ranged from micropores of O2 to chemically bound oxygen as peroxonitrite (O2NOO(-)), as well as peroxonitrite. Studies of the solution chemistry and solid state photochemistry were completed, which show that much of the oxygen evolved on wetting comes from thermal breakdown of peroxonitrite after it is dissolved. A chemical model is developed for the photochemical processes occurring during UV irradiation of solid nitrates which resolves the several contradictory models discussed in the literature in recent years. Author

N91-26079*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
OXYGEN PRODUCTION ON MARS: A FIGURE-OF-MERIT APPROACH Abstract Only
Bruce Preiss, Tom Pan, and Kumar Ramohalli *In its* Resources of Near-Earth Space: Abstracts 1991 p 33 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

A new approach is described toward evaluating the overall system performance in space missions; the objective is to demonstrate a new quantitative tool that can effectively synthesize and display the big picture. It considers a large number of individual components and factors that influence the big picture. The approach was found to be valuable in evaluating various options that must be considered in choosing one or more final ones. The application is especially suited to evaluate missions that consider ISRU. The Figure-of-Merit (FoM) can be different for different missions. In fact, it should be different for different priorities. Simple mass at launch, mass at the moment of departure from LEO, the payback time, the mass returned to LEO, the overall life-cycle costs, etc. are possible indicators of the FoM. After mentioning all of these possible definitions, the FoM for various historical missions will be presented. The FoM of a simple Mars Sample Return (MSR) mission is next presented. It is shown that the FoM is not only higher for missions employing ISRU, but that even among ISRU missions, several mundane propellant combinations are more desirable than the highest-performance propellants.

Author

N91-26080*# Rockwell International Corp., Downey, CA. Space Systems Div.

MISSION AND TRANSPORTATION SYSTEMS USES OF IN-SITU DERIVED PROPELLANTS Abstract Only **c28**

Ed Repic *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 34 (For primary document see N91-26019 17-91)

Avail: NTIS HC/MF A04 CSCL 22I

The uses of in-situ derived propellants are discussed for lunar and Mars transportation systems and the impact on mission architectures. Transportation systems include surface rovers, ascent/descent vehicles and space transfer vehicles at both the Moon and Mars. A brief survey of available propellant types is included. A brief description of typical transportation systems proposed for use on the Moon and Mars is presented. Comparisons are made of overall mission parameters such as mass, costs, schedules and performance assuming the use of in-situ derived propellants versus Earth supplied propellants using 4 different mission scenarios to cover the range of missions being studied today.

Author

N91-26081*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

POTENTIAL FOR THE IDENTIFICATION OF LOCALIZED WATER-BEARING REGIONS ON MARS Abstract Only

Ted Roush (San Francisco State Univ., CA.) and James B. Pollack *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 34 (For primary document see N91-26019 17-91)

Avail: NTIS HC/MF A04 CSCL 03B

Interpretations of airborne telescopic observations of Mars in the thermal infrared have identified absorption features due to several volatile-bearing minerals. The presence of some of these (e.g., carbonates) support previous suggestions that Mars once had a denser atmosphere early in its history. While these interpretations provide for ample scientific discussion, from the view of indigenous resource utilization the identification of hydrates is perhaps key to the exploration of Mars. Water is essential to a prolonged human presence in space and more specifically on Mars. Both life support and any agricultural endeavor require quantities of water which are cost prohibitive to transport over large distances. Additionally, water could provide a source of indigenous chemical fuel which could be used for transportation. Hydrates, from which water can be extracted may prove to be a valuable resource on the Martian surface. It is vital to assess the presence of special environments or localized regions on Mars in which hydrates are concentrated, and map the distribution of this potential resource.

Author

N91-26082*# Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.

EXPERIMENTAL DATA FROM AN OXYGEN PLANT FOR MARS Abstract Only

P. A. Schallhorn, J. Colvin, K. R. Sridhar, and Kumar Ramohalli *In its* Resources of Near-Earth Space: Abstracts 1991 p 34 (For primary document see N91-26019 17-91)

Avail: NTIS HC/MF A04 CSCL 03B

Experimental data are presented on various aspects of the plant operation intended to produce oxygen from the atmospheric carbon dioxide at any Martian site. A solid electrolytic cell is used in the tubular geometry. Anaerobic carbon dioxide is procured from a gas vendor and is used at a pressure of 1 bar (entrance to the plant). The variables include the voltage applied to the cell, the temperature of the cell, the current density, the flow rate and the duty-cycle. The oxygen production rates have been consistent with the specifications of the cell manufacturer. It is projected that a plant weighing between 145 and 197 kg can be built to produce 10 kg of oxygen per day. Various operational characteristics such as cell poisoning, carbon formation, nitrogen embrittlement, local current densities exceeding the breakdown potential for the cell material, reliability, risk, are all being quantitatively assessed.

Author

N91-26083*# Arizona Univ., Tucson. Planetary Image Research Lab.

PRIMARY IGNEOUS ROCKS ON MARS: COMPOSITION AND DISTRIBUTION Abstract Only

Robert B. Singer and Harry Y. McSween, Jr. (Tennessee Univ., Knoxville.) *In its* Resources of Near-Earth Space: Abstracts 1991 p 35 (For primary document see N91-26019 17-91)

Avail: NTIS HC/MF A04 CSCL 03B

The present knowledge of the crustal composition of Mars is synthesized and implications discussed for in-situ resource utilization. Sources of information include remote sensing observations, Viking XRF chemical measurements, and characteristics of the SNC meteorites (which most researchers now believe originated on Mars). There are a number of lines of evidence that abundant ferrous-iron rich igneous crustal rocks (and derivative soils) are available at or very near the current Martian surface at many locations on the planet. Most of these exposures show spectroscopic evidence for abundant pyroxene, consistent with basaltic compositions. The SNC meteorites, which have basaltic compositions, were also studied extensively. Interpretations of Mars crustal chemistry and mineralogy (petrology) based on these various sources are reviewed, and their consistencies and differences are discussed.

Author

N91-26084*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

PHYSICAL AND CHEMICAL PROPERTIES OF THE MARTIAN SOIL: REVIEW OF RESOURCES Abstract Only

C. R. Stoker, James L. Gooding, A. Banin, Benton C. Clark (Martin Marietta Aerospace, Denver, CO.), and Ted Roush *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 35 (For primary document see N91-26019 17-91)

Avail: NTIS HC/MF A04 CSCL 03B

The chemical and physical properties of Martian surface materials are reviewed from the perspective of using these resources to support human settlement. The resource potential of Martian sediments and soils can only be inferred from limited analyses performed by the Viking Landers (VL), from information derived from remote sensing, and from analysis of the SNC meteorites thought to be from Mars. Bulk elemental compositions by the VL inorganic chemical (x ray fluorescence) analysis experiments have been interpreted as evidence for clay minerals (possibly smectites) or mineraloids (palagonite) admixed with sulfate and chloride salts. The materials contained minerals bearing Fe, Ti, Al, Mg and Si. Martian surface materials may be used in many ways. Martian soil, with appropriate preconditioning, can probably be used as a plant growth medium, supplying mechanical support, nutrient elements, and water at optimal conditions to the plants. Loose Martian soils could be used to cover structures and provide

radiation shielding for surface habitats. Martian soil could be wetted and formed into abode bricks used for construction. Duricrete bricks, with strength comparable to concrete, can probably be formed using compressed muds made from martian soil. Author

N91-26085*# Rockwell International Corp., Downey, CA.
PRODUCTION AND USES OF LIQUEFIED ATMOSPHERE (CO2) ON MARS Abstract Only
R. D. Waldron *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 36 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Carbon dioxide is universally accessible on Mars, and can be liquefied and separated from residual atmospheric gases by various compress-refrigeration cycles. Liquid CO2, stored under elevated pressures, can be used as a source of high pressure gas for nighttime power generation at a Martian base powered by solar energy during the daytime. Carbon dioxide can also be used for vehicular power. The extractable energy per unit mass of CO2 can exceed that of commercial lead-acid batteries for operating cycles without heat addition. Improved performance is possible using heat input from the ambient atmosphere or thermochemical agents. A unique vehicular application uses pressurized CO2 as a non-combustion low performance propellant for intermediate distance surface transportation. The thermodynamic properties of CO2 are presented with typical operating cycles for the application classes described above. Author

N91-26086*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
DISTILLATION OF H2O FROM HARD-FROZEN MARTIAN PERMAFROST Abstract Only
A. P. Zent and O. Gwynne *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 36 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

The authors present a method for distillation of hard-frozen Martian permafrost. A cable-tool is drilled into hard frozem permafrost to a depth of 10 to 20 m. They calculate that a 10 m hole could be drilled in a few days. A 10 m shaft with a diameter equal to the bore is inserted into the hole, and a air tight tent-like structure is erected over the borehole. Photovoltaic cells mounted on the tent supply electrical energy that is dissipated in the shaft. Drilling power can be supplied by other sources. With 1000 watts, the shaft can be heated to near 350 K, producing relatively high temperatures in the vicinity of the borehole. Surrounding H2O is vaporized and diffuses up through the regolith. The authors calculate that a tent of a radius of no more than a few meters would intercept most of the H2O as it diffused to the surface. Calculations suggest that it would require perhaps 30 days to extract H2O from most of the volume drained by this technique. Assuming that the hard frozen regolith is no more than 10 percent ice, the author's calculate that that about 2890 kg of H2O could be extracted in 30 days. Since the nominal requirement for each crew member is about 5 kg/day, one such borehole might be expected to supply enough H2O to maintain a crew of 5 for perhaps 100 days. Additional engineering studies will be done to attempt to improve the capacity or efficiency of this method. Author

N91-26087*# Arizona Univ., Tucson. Dept. of Physics.
THE OPTIMUM SHAPE FOR A RIGID ROTATING SHELL ENCLOSING AN ISOTROPIC SPHERICAL PLANETARY MASS Abstract Only
Tatiana Covington *In its* Resources of Near-Earth Space: Abstracts 1991 p 36 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Analysis of the Dyson Sphere, an extremely advanced civilization's hypothetical construct entirely surrounding a star, shows that new stress inward to the star increases to maxima at the poles if the sphere is rotating. This is because the centrifugal force in the rotating frame of reference vanishes at zero rotational radius, which occurs at the poles. There is less of the centrifugal force at high latitudes than low to offset the star's gravity. A form is derived for a thin, rigid, rotating shell, surrounding a large pointlike mass and/or charge, which will experience the least possible net stress at every point upon it - a shape on which every point not on the shell's equator is as near as possible to being in orbit. In orbit, whose plane passes through the primary body's center of mass or of charge, F(grav), or Fg, is exactly opposite in direction to F(centrif), or Fc, and is equal in amount. At all points not on the equator, Fc will not entirely offset Fg, because of Fg's vector decomposition. However, both forces are always constrained to be equal in absolute amount everywhere on the shell, equator included. The derived shape, given by the figure of revolution around the x-axis of x = square root (y-1-72), will prove useful in large-scale space construction. Also, various engineering problems are discussed. Author

N91-26088*# Arizona Univ., Tucson.
COMPARATIVE ECONOMICS OF SPACE RESOURCE UTILIZATION Abstract Only **c12**
Andrew Hall Cutler *In its* Resources of Near-Earth Space: Abstracts 1991 p 37 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 22A

Physical economic factors such as mass payback ratio, total payback ratio, and capital payback time are discussed and used to compare the economics of using resources from the Moon, Mars and its moons, and near Earth asteroids to serve certain near term markets such as propellant in low Earth orbit or launched mass reduction for lunar and Martian exploration. Methods for accounting for the time cost of money in simple figures of merit such as MPRs are explored and applied to comparisons such as those between lunar, Martian, and asteroidal resources. Methods for trading off capital and operating costs to compare schemes with substantially different capital to operating cost ratio are presented and discussed. Areas where further research or engineering would be extremely useful in reducing economic uncertainty are identified, as are areas where economic merit is highly sensitive to engineering performance - as well as areas where such sensitivity is surprisingly low. Author

N91-26089*# Academy of Sciences (USSR), Leningrad. Fiziko-Tekhnicheskij Inst.
OUTER PLANETS AND ICY SATELLITES Abstract Only **c90**
E. M. Drobyshevski *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 37 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

The resources offered by the outer bodies in the Solar System, starting with the main belt asteroids and Jovian System, are not only larger and more diverse but may even be easier to reach than, say, those of Mars. The use of their material, including water and organic matter, depends exclusively on the general strategy of exploration of the Solar System. Of major interest in this respect are the large ice satellites - Titan, Ganymede, and Callisto. Motion through the planetary magnetospheres excites in their ice envelopes megampere currents which, in the presence of rocky, etc., inclusions with electronic conduction should lead to the bulk electrolysis of ice and accumulation in it of 2H2 + O2 in the form of a solid solution. With the concentration of 2H2 + O2 reaching about 15 wt. percent, the solution becomes capable of detonation by a strong meteoritic impact. An explosion of Ganymede's ice envelope about 0.5 By ago could account for the formation of the Trojans and irregular satellites, all known differences between Ganymede and Callisto, and many other things. The explosion of a small icy planet with M approx less than 0.5 Moon created the asteroid belt. Two to three explosions occurred on Io, and two on Europa. The specific features of the longperiod comets close to Saturn's orbit permit dating Titan's envelope explosion as 10,000 yr ago, which produced its thick atmosphere, young Saturn's rings, as well as a reservoir of ice fragments saturated by 2H2 + O2, i.e., cometary nuclei between the orbits of Jupiter and Saturn. Thus these nuclei should contain, besides organic matter, also 2H2 + O2, which could be used for

their transportation as well as for fuel for spaceships. Ices of such composition can reside deep inside Deimos, the Trojans, C-asteroids, etc. The danger of a future explosion of Callisto's electrolyzed ices, which would result in a catastrophic bombardment of the Earth by comets, may be high enough to warrant a revision of the priorities and strategy of space exploration. Author

N91-26090*# Nevada Univ., Reno. Dept. of Geology.
SOME THOUGHTS ON MERCURIAN RESOURCES Abstract Only
Stephen L. Gillett *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 38 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Virtually all scenarios on Solar System development ignore Mercury, but such inattention is probably undeserved. Once viable lunar and (probably) asteroidal facilities are established in the next century, Mercury warrants further investigation. Mercury's high solar energy density is a major potential advantage for space-based industries. Indeed, despite its higher gravity, Mercury is roughly twice as easy to leave as the Moon if the additional solar flux is taken into account. Moreover, with solar-driven technologies such as solar sails or electric propulsion, its depth in the Sun's gravity well is less important. Because Mercury is airless and almost certainly waterless, it will be an obvious place to export lunar technology, which will have been developed to deal with very similar conditions. Methods for extracting resources from anhydrous silicates will be particularly germane. Even without solar-powered propulsion, the discovery of low-delta-V access via multiple Venus and Earth encounters makes the planet easier to reach than had been thought. Technology developed for multi-year missions to asteroids and Mars should be readily adaptable to such Mercurian missions. Mercury will not be our first outpost in the Solar System. Nonetheless, as facilities are established in cis-Earth space, it probably merits attention as a next step for development.
Author

N91-26091*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PLANETARY ENGINEERING Abstract Only
James B. Pollack and Carl Sagan (Cornell Univ., Ithaca, NY.) *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 38 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Assuming commercial fusion power, heavy lift vehicles and major advances in genetic engineering, the authors survey possible late-21st century methods of working major transformations in planetary environments. Much more Earthlike climates may be produced on Mars by generating low freezing point greenhouse gases from indigenous materials; on Venus by biological conversion of CO2 to graphite, by canceling the greenhouse effect with high-altitude absorbing fine particles, or by a sunshield at the first Lagrangian point; and on Titan by greenhouses and/or fusion warming. However, in our present state of ignorance we cannot guarantee a stable endstate or exclude unanticipated climatic feedbacks or other unintended consequences. Moreover, as the authors illustrate by several examples, many conceivable modes of planetary engineering are so wasteful of scarce solar system resources and so destructive of important scientific information as to raise profound ethical issues, even if they were economically feasible, which they are not. Global warming on Earth may lead to calls for mitigation by planetary engineering, e.g., emplacement and replenishment of anti-greenhouse layers at high altitudes, or sunshields in space. But here especially we must be concerned about precision, stability, and inadvertent side-effects. The safest and most cost-effective means of countering global warming - beyond, e.g., improved energy efficiency, CFC bans and alternative energy sources - is the continuing reforestation of approximately 2 times 107 sq km of the Earth's surface. This can be accomplished with present technology and probably at the least cost. Author

N91-26092*# Mitre Corp., Bedford, MA.
ACCESSIBILITY OF NEAR-EARTH ASTEROIDS, 1990 Abstract Only **c90**
Neal D. Hulkower and Jack B. Child (World Space Foundation, Pasadena, CA.) *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 38 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Previous research which analyzed the accessibility of all known near-Earth asteroids is updated. Since then, many new near-Earth asteroids have been discovered, and 1928 DB, the most accessible asteroid at that time, has been recovered. Many of these recently discovered near-Earth asteroids have promising orbital characteristics. In addition to accessibility (as defined by minimum global delta v), ideal rendezvous opportunities are identified.
Author

N91-26093*# Construction Technology Labs., Skokie, IL.
LUNAR CEMENT AND LUNAR CONCRETE Abstract Only
T. D. Lin *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 39 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Results of a study to investigate methods of producing cements from lunar materials are presented. A chemical process and a differential volatilization process to enrich lime content in selected lunar materials were identified. One new cement made from lime and anorthite developed compressive strengths of 39 Mpa (5500 psi) for 1 inch paste cubes. The second, a hypothetical composition based on differential volatilization of basalt, formed a mineral glass which was activated with an alkaline additive. The 1 inch paste cubes, cured at 100C and 100 percent humidity, developed compressive strengths in excess of 49 Mpa (7100 psi). Also discussed are tests made with Apollo 16 lunar soil and an ongoing investigation of a proposed dry mix/steam injection procedure for casting concrete on the Moon. Author

N91-26094*# Harvard-Smithsonian Center for Astrophysics, Cambridge, MA.
AN OBSERVATIONAL INVESTIGATION OF THE COMET-ASTEROID CONNECTION Abstract Only **c90**
Jane X. Luu *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 39 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Recent observations indicate that comet nuclei and certain asteroids, particularly near-Earth asteroids (NEA) and the distant asteroids, may have much in common. The authors investigated the possible connection between comets and asteroids via two methods. A spectroscopic survey of two groups of asteroids that may be related to comets, namely the NESs and Trojan asteroids, indicates that we cannot dispel the hypothesis of a main-belt origin NEAs, while the Trojan survey shows that the Trojans and the known comet nuclei are spectrally similar over the wavelengths examined. Results of attempts to determine the mass loss rates of NEAs indicate that we cannot exclude the possibility that low-activity comets exist in the NEA population and have escaped detection simply because their small sizes result in mass loss rates which are below the detection limit. Author

N91-26095*# Shemakha Astrophysical Observatory, Azerbaijan (USSR).
NEAR-EARTH AND NEAR-MARS ASTEROIDS: PROGNOSIS OF PYROXENE TYPES Abstract Only **c90**
D. I. Shestopalov and L. F. Golubeva *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 40 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

The diagnostic signs of ferrous absorption band at 505nm and color index (u-x) found at main-belt asteroids and 6-parametric classification of light stone meteorites have been the basis of the work. The colorimetric data of light near-Earth and near-Mars asteroids from TRIAD and ECAS were analyzed. Composition fields

of pyroxenes were obtained for these asteroids by the value of (u-x) and 505-nm ferrous absorption band position within the pyroxenes quadrilateral. Pyroxenes of the S-asteroids from Apollo-Amor which have spectral parameters similar to achondrites may be presented by the diopside series. Author

N91-26096*# Tennessee Univ., Knoxville. Dept. of Geological Sciences.
HELIUM ABUNDANCES ON THE MOON: ASSUMPTIONS AND ESTIMATES Abstract Only
Lawrence A. Taylor *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 40 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Nuclear energy is a highly desirable source of energy, and He-3 is the most prized of the fusion reactants. As the Wisconsin Group has emphasized, He-3 may be the only true economic ore on the Moon. The lack of a shielding atmosphere on the Moon permits solar-wind alpha particles to impinge upon the lunar regolith and become implanted into the various solid components. In particular, large quantities of helium (5 to 50 ppm) are presented. The measured parameter of I(sub s)/FeO, a direct indicator of maturity and exposure age, can be used as a first approximation to predict the abundances of many solar-wind components in the soils. However, because ilmenite has a much higher retentivity for helium than the other phases, the TiO2 contents of the soils are better indicators of helium contents (Taylor, Space 90). High-Ti mare bassalt regions, such as at the Apollo 17 locale, appear to be the best areas for He mining (15 to 50 ppm He(sub T)), versus 3 to 9 ppm in the Highlands. However, the relationships between I(sub s)/FeO, TiO2 and He-3 contents are complicated - e.g., many of the most He-rich soils are immature to submature. The amount of He-3 in the regolith of the moon is estimated at 220,000 tons in the outer 2 m of the Maria. Author

N91-26097*# Los Alamos National Lab., NM.
DISCOVERY AND CHARACTERIZATION OF LUNAR MATERIALS: AN INCOMPLETE PROCESS Abstract Only
D. Vaniman *In* Arizona Univ., Resources of Near-Earth Space: Abstracts 1991 p 41 (For primary document see N91-26019 17-91)
Avail: NTIS HC/MF A04 CSCL 03B

Our knowledge of lunar materials is based on (1) sample collections (by the Apollo and Lunar missions, supplemented by Antarctic lunar meteorites); and (2) remote sensing (Earth-based or by spacecraft). The characterization of lunar materials is limited by the small number of sampled sites and the incomplete remote-sensing database (geochemical data collected from orbit cover 20 percent of the lunar surface). There is much about lunar surface materials that remains to be discovered. Listed are some features suspected form present knowledge: (1) Polar Materials; (2) Farside Materials; (3) Crater-Floor Materials; (4) Crater-Wall and Central Peak Materials; (5) Volcanic Shield and Dome Materials; (6) Transient-Event Materials; and (7) Meteoritic and Cometary Materials; This short list of likely discoveries isn't exhaustive. We know much about a few spots on the Moon, but little about the full range of lunar materials. Author

N91-26098 Pittsburgh Univ., PA.
EUROPA'S PHASE CURVE: IMPLICATIONS FOR SURFACE STRUCTURE Ph.D. Thesis
Deborah Lynn Domingue 1990 109 p
Avail: Univ. Microfilms Order No. DA9109430

Combining ground-based photoelectric measurements taken at 0.47 and 0.55 microns with Voyager vidicon images of Europa allowed construction of an integral phase curve with a range of phase angle coverage from 0 deg 3 min to 119 deg. The integral phase curve was analyzed using Hapke's photometric theory. The photometric parameters related to the textural characteristics of the surface, such as porosity and roughness, are remarkably similar for both wavelengths and hemispheres. If the narrow opposition peak is due to shadow hiding, the porosity must be large, on the order of 96 percent, which is much higher than that of a regolith generated by meteoritic gardening. The single particle scattering function is more back scattering on the leading hemisphere, which contradicts the expected scattering properties of a planetary surface that is being preferentially bombarded by ions on its trailing hemisphere. Examination of the disk-resolved phase curves for both bright and dark terrains on Europa indicates that the leading-trailing hemisphere dichotomy is not a result of the terrain forming processes. Author

N91-26099*# Stanford Univ., CA. Electronics Labs.
VOYAGER RADIO OCCULTATION BY THE URANIAN RINGS: STRUCTURE, DYNAMICS, AND PARTICLE SIZES Ph.D. Thesis Final Technical Report
Donna Leigh Gresh Feb. 1990 231 p
(Contracts NAGw-1210; JPL-953618; JPL-957887)
(NASA-CR-188539; NAS 1.26:188539; D845-1990-1) Copyright
Avail: NTIS HC/MF A11 CSCL 03B

Diffraction of Voyager 2's 3.6 and 13 cm wavelength microwaves by the Uranian rings is removed through an inverse Fresnel transform filtering procedure that accommodates the significant eccentricity of the rings. Resulting 50 m resolution profiles at two observation longitudes: (1) reveal remarkably detailed and longitudinally varying structure, (2) provide eccentricity gradient profiles of Rings alpha, beta, and epsilon which bring into question current theoretical models for observed rigid precession, and (3) suggest that two possible unseen satellites may confine some of the very sharp edges observed via resonant interactions. Author

N91-26100*# Arizona State Univ., Tempe. Dept. of Geology.
SUPPLEMENT TO PHOTOGRAPHIC CATALOG OF SELECTED PLANETARY SIZE COMPARISONS
Stephen Paul Meszaros Washington NASA Jun. 1991 32 p
(Grant NAGw-2102)
(NASA-CR-4379; NAS 1.26:4379) Avail: NTIS HC/MF A03 CSCL 03B

This document updates and extends the photographic catalog of selected planetary size comparisons. It utilizes photographs taken by NASA spacecraft to illustrate size comparisons of planets and moons of the solar system. Global views are depicted at the same scale, within each comparison, allowing size relationships to be studied visually. Author

N91-26101*# Lunar and Planetary Inst., Houston, TX.
WORKSHOP ON PRODUCTION AND USES OF SIMULATED LUNAR MATERIALS
1991 82 p Workshop held in Houston, TX, 25-27 Sep. 1989 Sponsored by NASA. Johnson Space Center
(NASA-CR-188606; NAS 1.26:188606; LPI-TR-91-01) Avail: NTIS HC/MF A05 CSCL 03B

A workshop entitled, Production and Uses of Simulated Lunar Materials, was convened to define the need for simulated lunar materials and examine related issues in support of extended space exploration and development. Lunar samples are a national treasure and cannot be sacrificed in sufficient quantity to test lunar resource utilization process adequately. Hence, the workshop focused on a detailed examination of the variety of potential simulants and the methods for their production. Author

N91-26102# Lawrence Livermore National Lab., CA.
PROPERTIES OF PLANETARY FLUIDS AT HIGH SHOCK PRESSURES AND TEMPERATURES
W. J. Nellis, A. C. Mitchell, N. C. Holmes, and P. C. McCandless Mar. 1991 18 p Presented at the 4th US/Japan Seminar on High Pressure Research in Mineral Physics: Applications to Earth and Planetary Sciences, Ise, Japan, 15-18 Jan. 1991
(Contract W-7405-eng-48)
(DE91-011195; UCRL-JC-106880; CONF-910196-1) Avail: NTIS HC/MF A03

Models of the interiors of Uranus and Neptune are discussed. Pressures and temperatures in the interiors can be achieved in representative constituent molecular fluids by shock compression. Experimental techniques are described and recent results for synthetic Uranus and hydrogen are discussed. DOE

N91-26103*# National Aeronautics and Space Administration, Washington, DC.
DIRECTORY OF RESEARCH PROJECTS, 1991. PLANETARY GEOLOGY AND GEOPHYSICS PROGRAM
Ted A. Maxwell, ed. Jun. 1991 174 p
(NASA-TM-4288; NAS 1.15:4288) Avail: NTIS HC/MF A08 CSCL 03B

Information is provided about currently funded scientific research within the Planetary Geology and Geophysics Program. The directory consists of the proposal summary sheet from each proposal funded by the program during fiscal year 1991. Information is provided on the research topic, principal investigator, institution, summary of research objectives, past accomplishments, and proposed investigators. Author

N91-25205*# Arizona Univ., Tucson. Lunar and Planetary Lab.
EXTRACTION OF VOLATILES AND METALS FROM EXTRATERRESTRIAL ORES
John S. Lewis *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 2 p (For primary document see N91-25203 17-25)
Avail: NTIS HC/MF A08 CSCL 03B

N91-25213*# Arizona Univ., Tucson. Dept. of Civil Engineering and Engineering Mechanics.
DEVELOPMENT OF CONSTRUCTION MATERIALS LIKE CONCRETE FROM LUNAR SOILS WITHOUT WATER
Chandra S. Desai, H. Saadatmanesh, and G. Frantziskonis *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1989 3 p (For primary document see N91-25203 17-25)
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N91-25235*# Arizona Univ., Tucson. Lunar and Planetary Lab.
HELIUM-3 IN THE LUNAR REGOLITH Abstract Only
T. Swindle *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 2 p (For primary document see N91-25223 17-25)
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N91-25241*# Arizona Univ., Tucson. Dept. of Geosciences.
DETERMINATION OF LUNAR ILMENTITE ABUNDANCES FROM REMOTELY SENSED DATA
J. R. Johnson, S. M. Larson, and Robert B. Singer *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 13 p (For primary document see N91-25223 17-25)
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N91-25243*# Arizona Univ., Tucson. Dept. of Mining and Geological Engineering.
CONTINUOUS MONITORING OF THE LUNAR OR MARTIAN SUBSURFACE USING ON-BOARD PATTERN RECOGNITION AND NEURAL PROCESSING OF ROVER GEOPHYSICAL DATA
J. W. McGill, C. E. Glass, and B. K. Sternberg *In its* NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 10 p (For primary document see N91-25223 17-25)
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N91-25248*# Washington Univ., Saint Louis, MO. Dept. of Earth and Planetary Sciences.
LUNAR OXYGEN AND METAL FOR USE IN NEAR-EARTH SPACE: MAGMA ELECTROLYSIS
Russell O. Colson and Larry A. Haskin *In* Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 9 p (For primary document see N91-25223 17-25)
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N91-25249*# Washington Univ., Saint Louis, MO. Dept. of Earth and Planetary Sciences.
LUNAR RESOURCES: TOWARD LIVING OFF THE LUNAR LAND
Larry A. Haskin and Russell O. Colson *In* Arizona Univ., NASA Space Engineering Research Center for Utilization of Local Planetary Resources 1990 15 p (For primary document see N91-25223 17-25)
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N91-25920*# Charles County Community Coll., La Plata, MD. Dept. of Biology and Physical Science.
LOW TEMPERATURE MEASUREMENT OF THE VAPOR PRESSURES OF PLANETARY MOLECULES Abstract Only
George F. Kraus *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 16-17 (For primary document see N91-25914 17-82)
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N91-25994*# Arizona Univ., Tucson. Lunar and Planetary Lab.
DEIMOS: A FEATURELESS ASTEROID-LIKE SPECTRUM Abstract Only
W. M. Grundy and Uwe Fink *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 77 (For primary document see N91-25982 17-90)
(Grants NAGw-1549; NGT-50661)
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N91-25995*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
NEAR-EARTH ASTEROID DISCOVERY RATE REVIEW Abstract Only
Eleanor F. Helin *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 90 (For primary document see N91-25982 17-90)
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N91-25996*# York Univ., Toronto (Ontario).
THE 1990 MB: THE FIRST MARS TROJAN Abstract Only
Kimmo A. Innanen, Seppo Mikkola, Edward Bowell, Karri Muinonen, and Eugene M. Shoemaker (Geological Survey, Flagstaff, AZ.) *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 96 (For primary document see N91-25982 17-90)
(Grant NAGw-1470)
Avail: NTIS HC/MF A13 CSCL 03B

N91-26001*# Harvard-Smithsonian Center for Astrophysics, Cambridge, MA.
A CCD COMPARISON OF OUTER JOVIAN SATELLITES AND TROJAN ASTEROIDS Abstract Only
Jane X. Luu *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 141 (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03B

N91-26009*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
A CENSUS OF THE ASTEROID BELT Abstract Only
E. F. Tedesco and G. J. Veeder *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 218 Sponsored in part by AFGL (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03B

N91-26017*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PLANETOLOGICAL IMPLICATIONS OF MASS LOSS FROM THE EARLY SUN Abstract Only
D. P. Whitmire, J. J. Matese (University of Southwestern Louisiana, Lafayette.), L. R. Doyle, and R. T. Reynolds *In* Lunar and Planetary Inst., Abstracts for the International Conference on Asteroids, Comets, Meteors 1991 1991 p 238 (For primary document see N91-25982 17-90)
Avail: NTIS HC/MF A13 CSCL 03B

92 SOLAR PHYSICS

Includes solar activity, solar flares, solar radiation and sunspots.

For related information see *93 Space Radiation.*

N91-26104 Stanford Univ., CA.
CHROMOSPHERIC DYNAMICS BASED ON INFRARED SOLAR BRIGHTNESS VARIATIONS Ph.D. Thesis
Greg Kopp 1990 153 p
Avail: Univ. Microfilms Order No. DA9108855

Infrared techniques were used to observe continuum emission from the solar chromosphere near temperature minimum in order to model the thermal response of the atmosphere to compressions due to 5-minute solar oscillations. Using one airborne and two-ground-based observations, simultaneous infrared intensity (temperature) and visible Doppler velocity measurements were acquired at several heights in the chromosphere, thus, allowing comparisons between the motions of the atmosphere gas and the thermal fluctuations. While 5-minute oscillations in the lower chromosphere are frequently thought to be evanescent, so that the compression of the gas is in phase at all heights, the temperature changes due to these oscillations are found to vary in phase with altitude, implying the gas behaves non-adiabatically in this region. The phases between the velocities of the gas and the temperature fluctuations were determined at several heights near temperature minimum. The chromosphere was then modelled as a planar gravitationally-stratified gas with thermal relaxation toward an equilibrium, isothermal temperature permitted in the equation describing temperature change with compression. The rates of thermal relaxation at different altitudes were estimated from the observed phases between the infrared and visible data. The relaxation times were found to vary from 30 seconds at an altitude of 350 km above the photosphere to roughly 200 seconds at 600 km altitude. The effects of compression on the opacity of the gas were also studied, in order to predict the consequences of a non-isothermal atmosphere on the continuum observations. An estimate of the energy lost from solar oscillations due to thermal relaxation is calculated for the altitudes observed, and it appears that solar oscillations may be partially responsible for heating the lower chromosphere by thermal relaxation. Author

N91-26105 California Univ., Los Angeles.
SEISMIC ANALYSIS OF THE SUN FROM INTERMEDIATE AND HIGH-DEGREE p-MODES Ph.D. Thesis
Sylvain Gereon Korzennik 1990 264 p
Avail: Univ. Microfilms Order No. DA9111309

Solar oscillations provide a tool to investigate the internal and dynamics of the Sun. While accurate measurements of the solar acoustic spectrum characteristics were performed for low and intermediate degree modes, only a limited set of short time baseline measurements for high-degree modes was available. An accurate and more reliable set of measurements for these high degree modes is provided. High spatial resolution full disk Dopplergrams of the solar surface were acquired at the Mt. Wilson 60 feet solar tower during the summer of 1988, using a Doppler analyzer based on the sodium magneto-optical filter. Twenty consecutive days of observations have been reduced to spherical harmonic coefficient time series, for degrees l is less than or equal to 600. The time series were then Fourier transformed in order to estimate the corresponding power spectra. From these power spectra, frequency splittings were estimated for degree 20 is less than or equal to l is less than or equal to 600. At low and intermediate degree, individual modes could be isolated, and hence reliable tesseral measurements were obtained. At high degree, the presence of mode blending introduced systematic errors in the tesseral frequency splitting determination. The nature of these systematics were carefully studied, but simulations were unable to reproduce in detail the observed systematics, and therefore, an ad-hoc procedure was developed to correct for them. Alternatively, sectoral frequency splittings, shown to be less sensitive to mode blending systematics, have provided a more reliable estimate of the frequency splitting for these high degree modes. From collapse (M = 0) spectra modal frequencies, amplitudes and lifetimes were estimated for 20 is less than or equal to l is less than or equal to 600. The required corrections for mode blending, point spread function attenuation, and finite observing run were applied. These new measurements are compared with previous determinations and theoretical predictions. Dissert. Abstr.

N91-26106# Lawrence Livermore National Lab., CA.
PLASMA PLUMES FOR TAPPING THE ELECTROMOTIVE FORCE OF THE SOLAR WIND
J. H. Hammer 15 Apr. 1991 22 p
(Contract W-7405-eng-48)
(DE91-011253; UCRL-ID-106990) Avail: NTIS HC/MF A03

Highly-conducting plasma plumes ejected across the interplanetary magnetic field are proposed as a technique for extracting electric power from the solar wind. Although the power density of the solar wind is very low (approximately 10(exp -3) W/sq m), plumes generated by plasma guns may be capable of extending thousands of kilometers to generate more than 10 megawatts. Calculations indicate that the extractable power is proportional to the mass ejection rate of the plume, with net power production possible when the plume velocity is sufficiently less than the solar wind Alfven velocity (approximately 80 km/sec). Applications could include space propulsion outside of planetary magnetospheres and a lunar power station. DOE

N91-25931*# Florida Univ., Gainesville. Dept. of Astronomy.
ATMOSPHERIC OCCULTATION OF A SOLAR FLARE IN HARD X RAYS Abstract Only
Kwan-Yu Chen *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 29 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 03B

N91-25940*# Alfred Univ., NY. Dept. of Physics.
SOLAR FLARE HARD AND SOFT X RAY RELATIONSHIP DETERMINED FROM SMM HXRBS AND BCS DATA Abstract Only
G. David Toot *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 38 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 03B

93 SPACE RADIATION

Includes cosmic radiation; and inner and outer earth's radiation belts.

For biological effects of radiation see *52 Aerospace Medicine.* For theory see *73 Nuclear and High-Energy Physics.*

N91-26107*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
RADIATION RISK PREDICTIONS FOR SPACE STATION FREEDOM ORBITS
Francis A. Cucinotta, William Atwell, Mark Weyland, Alva C. Hardy, John W. Wilson, Lawrence W. Townsend, Judy L. Shinn, and Robert Katz (Nebraska Univ., Lincoln.) Washington Jun. 1991 22 p (NASA-TP-3098; L-16903; NAS 1.60:3098) Avail: NTIS HC/MF A03 CSCL 03B

Risk assessment calculations are presented for the preliminary proposed solar minimum and solar maximum orbits for Space Station Freedom (SSF). Integral linear energy transfer (LET) fluence spectra are calculated for the trapped proton and GCR environments. Organ dose calculations are discussed using the computerized anatomical man model. The cellular track model of Katz is applied to calculate cell survival, transformation, and mutation rates for various aluminum shields. Comparisons between relative biological effectiveness (RBE) and quality factor (QF) values for SSF orbits are made. Author

N91-26108 Kansas Univ., Lawrence.
THE IMPACT OF TRAPPED RADIATION ON NATURAL SATELLITES IMBEDDED IN PLANETARY MAGNETOSPHERES Ph.D. Thesis
Edwin Vern Bell, II 1990 300 p
Avail: Univ. Microfilms Order No. DA9110861

Multiple spacecraft encounters with the magnetospheric regions surrounding the gaseous giants of our solar system have shown time and spatial variations in the durably trapped particle population and the magnetic field itself. Many of the proposed mechanisms for these variations involve the interaction of the ambient medium with the natural satellites imbedded in the magnetosphere. Several studies have been made of this interaction with varying degrees of success, but few have combined all of the complexities which the problem has required. Data taken by Voyager 1 during its flyby of Europa's orbit is used as a case study of the complications of traditional approaches. A means of resolving some of these difficulties is presented. A method for tracing particles from their observation point by the spacecraft is used to explain some of the energy and pitch angle dependencies of the Voyager 1 observations. Author

N91-26109 Durham Univ. (England).
THE THERMAL AND NONTHERMAL RADIO EMISSION FROM THE GALAXY Ph.D. Thesis
Alison Broadbent 1989 214 p
Avail: Univ. Microfilms Order No. BRD-91813

It is shown that a detailed correlation exists between IRAS 60 micron band emission from the galactic disc and radio continuum emission measured at a similar angular resolution at 11 and 6 cm. The emission at these short radio wavelengths is predominantly from thermal bremsstrahlung in regions of ionized gas and so the strong correlation, which holds for the diffuse, extended emission as well as the discrete, compact sources, indicates that an important contribution to the 60 micron emission is associated with HII regions. Isolation of this component of the 60 micron infrared emission has involved the estimation of the zodiacal light contamination and detailed modeling of the HI-associated dust emission. The residual 60 micron emission can then be used as a tracer of radio thermal emissions. On the small scale, this enabled a search for new supernova remnant candidates in the 11 cm survey of Reich et al. and the 6 cm survey of Haynes et a. close to the inner galactic plane. On the large scale, the thermal and non-thermal emission of the 408 MHz all-sky survey of Haslam et al. were separated from the whole of the galactic plane and within approximately 8 degrees of the plane. From the thermal galactic emission, average infrared excess, the total 60 micron luminosity, and total mass of HII in the galaxy were estimated. The clearer picture obtained of the non-thermal emission of the galaxy has allowed for improvement on the previous attempts to model the synchrotron emission in terms of the cosmic ray electron distribution and magnetic field variation modulated by the galactic spiral structure. Dissert. Abstr.

N91-26110# Tokyo Univ. (Japan). Inst. for Nuclear Study.
ARE SUPER-HYPERNUCLEI FOUND IN COSMIC RAYS?
Hidezumi Terazawa Oct. 1990 12 p
(DE91-772207; INS-851) Avail: NTIS HC/MF A03

In order to find whether the two events with the charge of Z=14 and the mass number of A approximately 370 recently observed in cosmic rays are super-hypernuclei (or strange quark matter) as claimed, the charge-to-mass-number ratio (Z/A) of super-hypernuclei is investigated in the quark-shell model. Although a small Z/A ratio is always preferable for super-hypernuclei, such a small ratio of 3 to 30 may be realized as Z less than or equal to square root of 2/3 A(exp 1/2) if the nuclei are created spontaneously from bulk strange quark matter due to the Coulomb attraction. DOE

N91-25928*# Gallaudet Coll., Washington, DC. Dept. of Physics.
MINIMUM LENGTH Pb/SCIN DETECTOR FOR EFFICIENT COSMIC RAY IDENTIFICATION Abstract Only
H. David Snyder *In* Maryland Univ., The 1989 NASA-ASEE Summer Faculty Fellowship Program in Aeronautics and Research Sep. 1989 p 26 (For primary document see N91-25914 17-82)
Avail: NTIS HC/MF A04 CSCL 03B

99 GENERAL

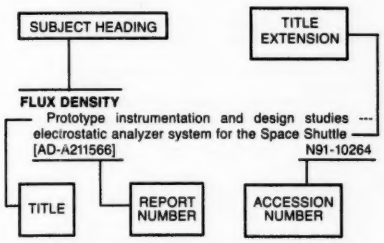
N91-26111# Department of Energy, Washington, DC.
TECHNOLOGY 1990
Jan. 1991 192 p
(DE91-005072; DOE/ER-0484P) Avail: NTIS HC/MF A09

The U.S. Department of Energy (DOE) laboratories have a long history of excellence in performing research and development in a number of areas, including the basic sciences, applied-energy technology, and weapons-related technology. Although technology transfer has always been an element of DOE and laboratory activities, it has received increasing emphasis in recent years as U.S. industrial competitiveness has eroded and efforts have increased to better utilize the research and development resources the laboratories provide. This document, Technology '90, is the latest in a series that is intended to communicate some of the many opportunities available for U.S. industry and universities to work with the DOE and its laboratories in the vital activity of improving technology transfer to meet national needs. Technology '90 is divided into three sections: Overview, Technologies, and Laboratories. The Overview section describes the activities and accomplishments of the DOE research and development program offices. The Technologies section provides descriptions of new technologies developed at the DOE laboratories. The Laboratories section presents information on the missions, programs, and facilities of each laboratory, along with a name and telephone number of a technology transfer contact for additional information. Separate papers were prepared for appropriate sections of this report. DOE

N91-26112*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LANGLEY AEROSPACE TEST HIGHLIGHTS, 1990
May 1991 184 p
(NASA-TM-104090; NAS 1.15:104090) Avail: NTIS HC/MF A09 CSCL 05B

The role of NASA-Langley is to perform basic and applied research necessary for the advancement of aeronautics and spaceflight, to generate new and advanced concepts for the accomplishment of related national goals, and to provide research advice, technological support, and assistance to other NASA installations, other government agencies, and industry. Some of the significant tests are highlighted which were performed during 1990 in the NASA-Langley test facilities, a number of which are unique in the world. Both the broad range of the research and technology activities at NASA-Langley and the contributions of this work toward maintaining U.S. leadership in aeronautics and space research are illustrated. Other highlights of Langley research and technology for 1990 are described in Research and Technology 1990 Langley Research Center. Author

Typical Subject Index Listing



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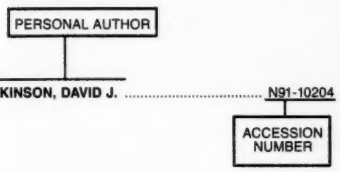

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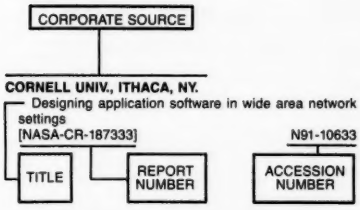

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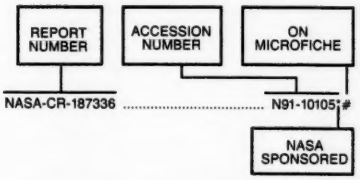

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